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WILEY'S HEALTH SERIES

NUTRITION HYGIENE PHYSIOLOGY

BOOK ONE

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FROM

Charles William Eliot.

WILEY'S HEALTH SERIES

BOOK ONE

II. The Elements of the Air

What have you learned about air? You have learned that air is an invisible gas without taste or smell. You can feel it, measure it, and weigh it. Now you all want to know what a gas is and how a gas differs from other forms of matter.

What are the forms of matter? All the forms of matter with which we are familiar are of three classes: solid, liquid, and gaseous. A solid body, as we all know, sticks together, keeps its form, and can be fashioned or made into various shapes. A liquid body, on the other hand, keeps its form only if held together by the walls of a container or vessel, as water in a cup. Pour water into a cup until it is full. Now if there is a hole in the bottom of the cup the water will at once begin to run out and will keep running out of this hole until the cup is empty.

Rock and pool. A solid and a liquid body

If you look at water or any other liquid in an

open vessel you will find that the top of it is always level. Now what is it to be level? That seems a simple question, and yet it is a very important one. To be level, a surface must fit exactly with the surface of the earth, if the earth were perfectly smooth; that is, if there were no hills, no hollows, no river beds, no sea beds on it. The free or upper surface of a liquid is always level, because of the flowing nature of the liquid itself.

A pail of water, showing the level surface of a liquid

How does a gas differ from a solid and a liquid? A solid has a fixed shape; a liquid has no fixed shape, but it occupies a limited space; a gas fills the space it is put in, whatever the size or shape of the space. All the surfaces of a solid are limited. The top surface, the side surfaces, and the under surface, all are unchanging and limited, just as a block is always the same size and shape wherever it is. A liquid has only one surface limited—that is, its upper surface. A gas has no surface limited; it moves in all directions. Air is a gas.

Standing by a pool of water on a foggy morning, you may see a rough stone at the water's edge, the smooth surface of the water, and the fog, which seems to extend everywhere. Thus

WILEY'S HEALTH SERIES

NUTRITION—HYGIENE—PHYSIOLOGY

BOOK ONE

By

HARVEY W. WILEY, M.D.

Formerly chief chemist of the United States Department of Agriculture. Editor of "Good Housekeeping's" Bureau of Foods, Sanitation, and Health. Author of "Foods and Their Adulterations," "Principles and Practice of Agricultural Analysis," "The Lure of the Land," "Not by Bread Alone"

Illustrated by

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HEALTH READER

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A FOREWORD

I believe it was George Ade who said, "If you want to uplift, get beneath." This sentiment is peculiarly applicable to the study of physiology in the schools. Such terms as "anatomy," "physiology," and "hygiene" terrify the children, and to a certain extent make them antagonistic to the study. I have long thought that the proper way to get children interested in this matter was to make the subject a living one. I have sought to get entirely under it and to present it in a vital way. My experience is that children are easily interested in matters that pertain to their daily life if we go at it in the proper spirit. Instead, therefore, of the dry details of physiology, I have tried to lead the child into the midst of the phenomena of the life he is living and to tell him in simple language of the character of the environment in which he lives.

I begin by taking him outdoors and allowing the wind to blow in his face. I lead him to the fireplace and let him warm his fingers. I take him to the spring and show him the water that he drinks. I go with him into the fields to watch the growing food. I visit with him the mills where this food is being prepared for consumption. I tell him of those things which are vitally related to his daily life and which are the groundwork of his health and growth. I have endeavored to put the material into the form in which the child naturally absorbs it. The child is an interrogation point. He asks questions. I have taken the questions which have been suggested to me by talking with children, and have tried to answer

contains these natural constituents in the quantities in which ordinarily they are to be found in the great ocean of air surrounding us.

When is air impure? The air is impure when it contains too much or too little of any one of its natural constituents. For instance, if oxygen, which is the most active substance in the air and the one on which the continuation of life depends, is diminished in quantity the air is impure. If, on the other hand, oxygen is increased in quantity the air is also impure. If the quantity of oxygen is decreased, then we have to take in a great deal more air to perform the functions of life; if it is increased the burning of the foods and tissues in the body would go on more rapidly and we should become ill and have fever. If there were no oxygen in the air we could not live; also, if the air consisted entirely of pure oxygen it would speedily cause us to die.

The air is also impure if unnatural and noxious or harmful substances are present in it. If you approach a gas factory you will smell an odor due to the presence in the air of little particles of bad-smelling gases. If you go near a refrigerating or ice-making establishment you are likely to notice an odor of ammonia which has escaped from the condensing machinery. If you happen to be in Chicago, especially when

good-smelling material. The attar of roses, the *eau de Cologne*, and all the various perfumes which a young lady puts on her handkerchief have these properties.

In our homes we are all familiar with the odors, generally pleasant, of the cooking dinner. Sometimes, though, these odors are unpleasant; for instance, when the odor of boiled cabbage or of frying fish fills the house.

All these instances illustrate the many substances which the air may contain, not to speak of the dust and solid particles which may also be present in the air. It is evident that the air is a really very complex mixture, but our attention is specially fixed on the fact that its chief characteristic, so far as human life is concerned, is its property of supporting life.

Can we live without air? Most of you have heard of accidents in which people lost their lives either by drowning or by suffocation. Accidents of this kind forcibly illustrate the fact that we can live only a few minutes without air. If you try to hold your breath, you experience no discomfort for the first few seconds. But no matter how strong the will power may be, no one can hold his breath long enough to kill himself. Nature asserts her supreme authority over the will of the individual.

Divers who have practiced for a long while

WILEY'S HEALTH SERIES

BOOK ONE

I. The Air We Breathe

What is the air? The air is an invisible gas, without taste or smell. It covers the whole surface of the earth and enters into every hole and crack in the ground. It also enters the ground itself, finding its way to a great depth between the particles of soil.

You have felt the wind blow in your face, have you not? Once, perhaps, your cap was carried away by the wind, and you ran after it as fast as you could. But the same wind raised such a cloud of dust you could hardly see which way to run. Fortunately the cap struck against a tree or fence, or against the curbstone, and

A lively chase

can do without breathing. Air is a constant, necessary, and indispensable element of life.

What takes place during the process of breathing? The process of breathing is a simple, mechanical action, involuntary as a rule, by means of which air is taken into and sent out from the lungs. It is easy to breathe purposely, but as a rule breathing is wholly involuntary. We are asleep about one third of our time, and during sleep we are wholly unconscious of breathing. Unless we are taking exercise or purposely turn our attention directly to it, the act of breathing is just as unconscious during our waking hours as it is during sleep.

How often do we breathe? There is no rule by means of which we can measure the frequency of breathing, except by counting for each person. It varies greatly in different individuals and at different ages. We do not breathe nearly so frequently when we are at rest as when we are engaged in exercise. In ordinary circumstances, that is, when working at his ordinary occupation, the grown person will breathe about eighteen times a minute. Children breathe more frequently than grown persons, and old persons also breathe more frequently than people in the prime of life. Sickness also causes a difference in the rate of breathing. Usually the more severe the disease, the more rapid the

breathing. Especially is this true in diseases of the heart and the lungs.

How much air do we breathe at one time? This too can be answered only in a general way. The amount of air which is taken at each breath depends upon the size of the lungs of the individual and the way he uses them. If we practice deep breathing—that is, if we make a conscious effort to fill the lungs as full as we can—we soon acquire an unconscious habit of deep breathing, thus increasing the capacity of the lungs. The purpose of certain gymnastic exercises is to increase the lung capacity. This is true especially of exercises of the arms and shoulders combined with deep breathing. Such exercises increase the capacity of the lungs. When the lungs are diseased, as in tuberculosis and pneumonia, their capacity is diminished, and therefore the frequency of breathing is increased.

A grown person in good health, weighing one hundred fifty pounds, will generally take about a pint of air into his lungs at each breath. Children, naturally, take less, and the smaller they are the smaller the quantity of air they can take in.

What is the result if a person is deprived of fresh air? If a person were confined in a room ten feet square and ten feet high, in which there

was no means of ventilation, the oxygen, which is the active agent in maintaining the heat of the body, gradually would all be used up. The carbon dioxide, which is formed when the food and tissues of the body are burned, would be constantly increasing in quantity. Suffocation and death would finally result, although the end would be slow in coming.

Were it not for the constant replenishing of the oxygen by plant life as already explained, the air in which we live would after a long interval of time become unfit to breathe.

QUESTIONS TO HELP THE PUPIL

1. Into what three classes may the forms of matter be classified? 2. How do these classes differ? 3. What do you discover by observing a gas that has color? 4. Of what gases is air principally made up? 5. How much of the air is oxygen? How much nitrogen? 6. How can you make carbon dioxide? 7. How is carbon dioxide formed in the body? 8. What gas do plants use? What gas do they throw out? 9. What gas is necessary for the burning of food in the body and for gas flames or other fires? 10. When can you see water in the air? 11. Are there other substances in the air besides oxygen, carbon dioxide, and water? 12. What is the term applied to elements composing the air? 13. When is air impure? 14. How can we tell the air is impure? 15. Can we live without air? 16. What happens when a person breathes in a room that is not ventilated? 17. What is the value of exercises of the arms and shoulders combined with deep breathing?

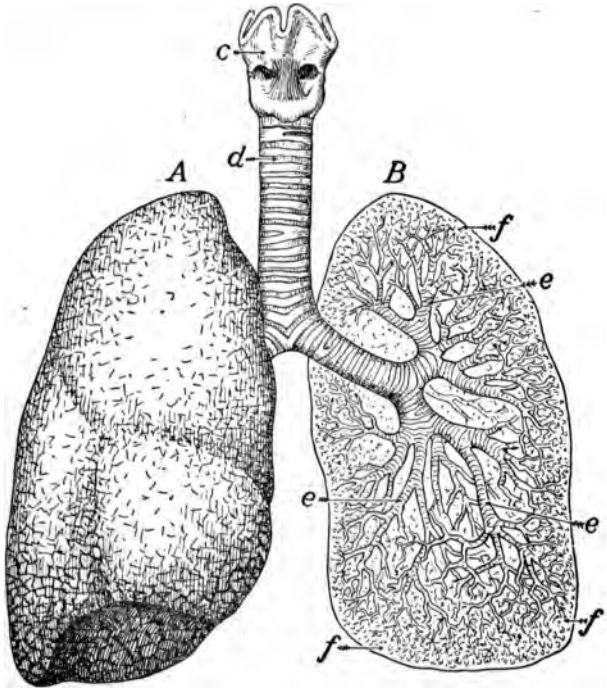
18. What is breathing? 19. What do we mean when we say that breathing is involuntary? 20. Why is it necessary to breathe? 21. How much air does a grown person take in at each breath?

III. The Organs of Breathing

What are the lungs? The lungs are the organs of breathing. They are full of little air cells and are richly supplied with blood vessels. These organs are placed one on the right side and one on the left side of the cavity in the upper part of the trunk known to scientific men as the *thorax* but commonly called the *chest*. This cavity is formed chiefly by an inclosing structure of bones called the *ribs*. Leading to the lungs from the mouth and the nostrils is a tube called the *trachea*, known commonly as the windpipe. This tube divides into two branches, one going to the right lung and one to the left lung. These branches are called the *bronchial tubes*. An inverted tree is an excellent illustration of the appearance of the windpipe and the bronchial tubes. (Fig., p. 22.) The trunk of the tree is the windpipe; the roots, the openings into the mouth and nostrils. The two main branches are the bronchial tubes. These tubes branch out into numerous smaller tubes like the smaller limbs of a tree.

The comparison may go still farther. In the lungs are numerous small cavities or pockets, and these may be compared with the leaves of

the tree. In fact, the tree absorbs air in a way that is a very good illustration of what takes place in the lungs, except that the act of breath-

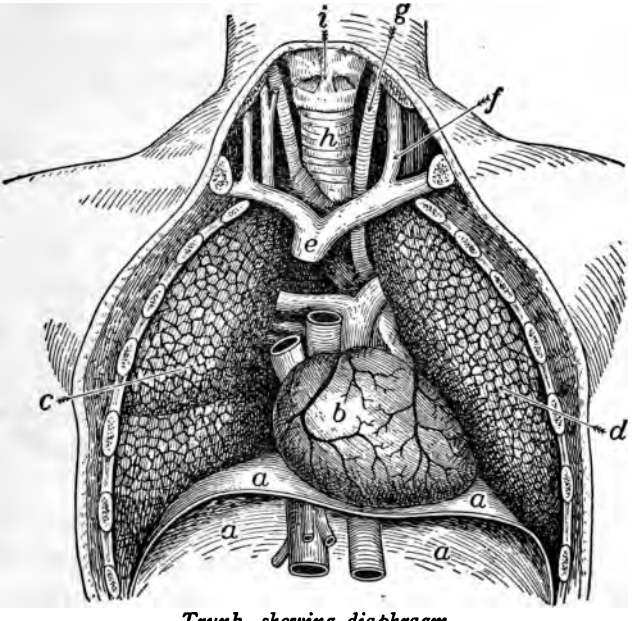


Lungs, showing larynx, trachea, and bronchial tubes
A, right lung, exterior; *B*, left lung, section view; *c*, larynx; *d*, trachea; *e*, small bronchial tubes; *f*, air sacs

ing goes on in inverse or opposite order. In the human body you breathe through the openings of the windpipe and distribute to the branches and the lung cavities; the tree breathes through its leaves and distributes to the branches and the

trunk and roots. The human being takes in oxygen and gives off carbon dioxide; the tree takes in carbon dioxide and gives off oxygen. Thus the comparison is complete but in inverse order.

The lungs are surrounded by a membrane or



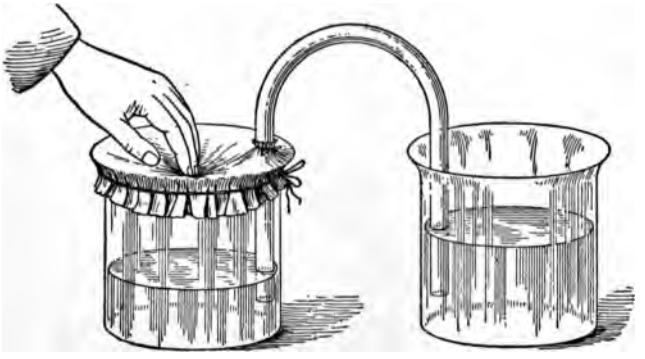
Trunk, showing diaphragm

aa, diaphragm; *b*, heart; *c*, right lung; *d*, left lung; *e*, superior vena cava; *f*, jugular vein; *g*, carotid artery; *h*, trachea; *i*, larynx

covering known as the *pleura*, and are located in the cavity inclosed by the ribs. At the back of this cavity is the backbone, or spinal column. At the bottom is a strong muscular partition called the *diaphragm*. It is by the action of the

diaphragm and of the muscles contracting and expanding the ribs that the capacity of the thorax may be increased or diminished.

By the expansion of these muscles and the movement of the diaphragm downward, the cavity or box in which the lungs are inclosed is increased in size and the air enters through the mouth and nostrils to fill this increased cavity.



Experiment illustrating breathing

By the contraction of the muscles of the ribs and the movement of the diaphragm upward, the holding capacity of the cavity or thorax is diminished and the excess of air in the lungs is expelled. Thus breathing is brought about by the contraction and expansion of the thorax.

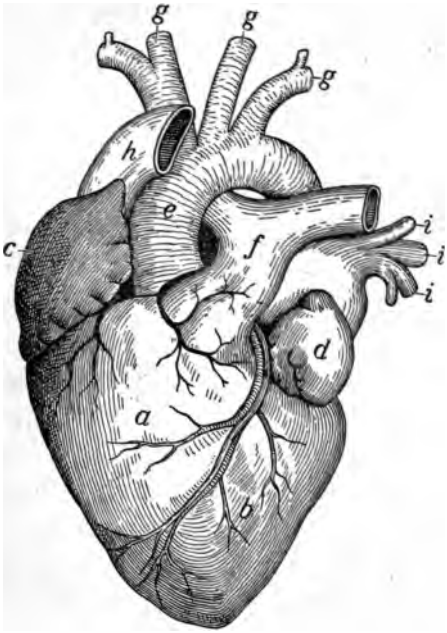
This can easily be illustrated by a simple experiment. If you cover the open top of a jar with a piece of rubber and press down on the rubber, you will diminish the capacity of the

jar. If you stop pushing and take your hand away the rubber will come back to its horizontal position and the capacity of the jar will be the same as it was at first. If you attach a curved tube to the jar and put one end of the tube in water you will find that when you push down on the rubber cover the air will be forced out of the jar through the tube into the water. On withdrawing your hand a portion of the water will be drawn through the tube into the jar. In this way you illustrate the mechanism by means of which breathing takes place.

How are the lungs supplied with blood? Between the lungs, point downward, lies the pear-shaped heart, about the size of one's fist. The right half of the heart receives the impure blood and sends it to the lungs through the *pulmonary* or lung arteries. The left half receives it back from the lungs through veins, and with a strong, sudden squeeze of the heart muscles, sends it over the whole body, through a great artery called the *aorta*. Back comes the blood again through veins to the *right* side of the heart. Then the work must all be done over again. But it takes only about one minute (72 to 75 heart beats) for all the blood in the body to complete these two journeys.

Each half of the heart is itself divided into two chambers. The upper chambers (called

auricles) receive the blood from the veins; the lower ones (called *ventricles*) send it out through arteries. Little valves, like trap doors, between the auricles and ventricles, help to keep the blood from flowing the wrong way.



The heart, showing veins and arteries connected with it

a, right ventricle; *b*, left ventricle; *c*, right auricle; *d*, left auricle; *e*, aorta; *f*, pulmonary artery; *g*, branches of the aorta; *h*, superior vena cava; *i*, pulmonary veins

What happens to the air when it reaches the little pockets or cells in the lungs? The cells of the lungs are provided with innumerable small blood vessels so arranged that the blood, loaded with water and carbon dioxide, comes into all parts of the lungs on its way to and from the heart. When the blood enters the lung cells some of the particles of carbon dioxide and water pass out of the blood and through the cell walls into the air

in the cells, and particles of oxygen pass through in a contrary direction from the air into the blood. In this way each little particle of blood is relieved of a load of carbon dioxide and water, after which each takes up a load of oxygen from the air. At the same time it changes color. As the blood, on its return from the tissues to the lungs, enters the little vessels in the lung cells it has a bluish tint. When it passes out it has a red tint. If you dress one little girl in a blue dress and another little girl in a red dress, and have the little girl in blue carry a lot of blue marbles and the little girl in red carry a lot of red marbles, and then have them exchange marbles and dresses, you will have an illustration of what is going on in the lungs. The little girl in blue represents the blood in the vessels lining the cell walls, and the little girl in red the air breathed into the cells. The blue marbles are particles of carbon dioxide and water, and the red marbles are particles of oxygen. These exchanges are continually taking place in the lungs like innumerable millions of little girls dressed in blue and red exchanging dresses and marbles.

The little blood globules which have thus taken on a load of oxygen go to the heart and are then sent through the arteries to all the

tissues of the body. On this journey they give up their loads of oxygen and again take on loads of carbon dioxide and water, then return through the veins on the way to the heart and the lungs. This process is constantly going on. Every few moments all the blood that is in the body passes through the lungs. It is also clear that the air that enters the lungs bearing its full quantity of oxygen passes out of the lungs bearing a full load of carbon dioxide and water.

Can we ever see the water in the air we breathe out of our lungs? Yes, it is not an unusual thing to see the water in the air we breathe out of our lungs. All you have to do is to go out of doors on a cold day and blow, and you will see what we call the steam or the fog of the breath. The cold air condenses the water in the breath and forms it into small particles or globules like a fog. Another easy way to prove that there is water in the breath is to breathe upon a mirror. The cold glass will condense the little particles of moisture in the breath so that you can see them.

Is there any way you can see the carbon dioxide in the breath? No, not directly. It requires a very low temperature to condense carbon dioxide. It can be done, however, and the teacher of chemistry in the high school may show you frozen carbon dioxide. You may see it,

however, in an indirect way. If you will breathe through a glass tube into a little clear lime water, which you can easily make from a fragment of lime or which you can buy at the drug store, you will soon see the whole mass of water become white. But these little particles you see are not carbon dioxide. They are particles of carbonate of lime, the same thing as limestone or marble. This carbonate of lime is formed by the union of the carbon dioxide forced out of your lungs with the particles of lime in the water.

Blowing expired air through limewater

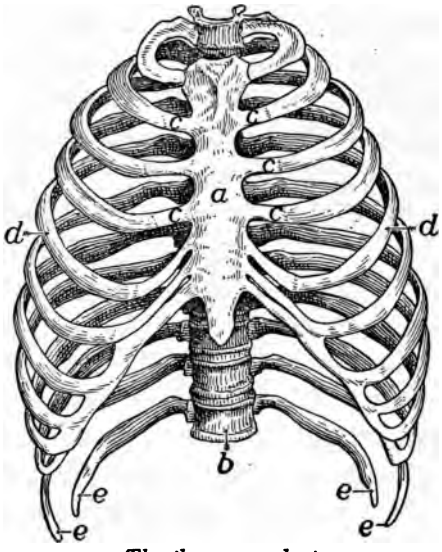
What is the practical meaning of these facts? This experiment shows you very plainly that if you breathe the same air over and over again you are continually loading it up with carbon dioxide and water. The water is not so very bad, because only a certain amount of it can be held in the air. Anything over this amount of water will be deposited or thrown off. The

carbon dioxide, however, is not deposited. It remains in the air indefinitely, and in unlimited quantities, and its presence cannot be known except in the way described.

What precautions does nature take to protect the lungs? Nature takes many precautions to protect the lungs. As we have learned, the lungs are covered by a membrane known as the *pleura*. They are located in the thorax or chest, a cavity that is entirely closed in by walls of bone and muscle. There is no communication between the thorax and the external atmosphere, although the interior of the lungs is connected directly with the outside air through the windpipe. No air can get into the thorax unless it leaks in through the lungs or through a puncture in the side walls. The walls of the thorax, with the exception of the diaphragm, consist of hard, bony materials,—namely, the ribs, the backbone, and the *sternum* or breastbone. This cavity therefore cannot collapse, and is able to resist the pressure of the atmosphere, which is about fifteen pounds on every square inch.

The walls of the thorax, moreover, are supported also from the inside. The lungs, being porous and expansible or easily stretched, and being in communication with the external air through the *trachea* or windpipe and the bronchial tubes, are expanded by the air pressure

until they entirely fill the lung space. The lungs, therefore, do not hang loosely in an open space, but, in a state of health, are entirely expanded so that their enveloping lining (the pleura) touches the internal walls of the thorax. Thus, by the pressure of the air within the lungs, the walls of the thorax are supported from the inside also, and are prevented from yielding under the pressure of the air on the outside.



The thorax or chest

a, sternum or breastbone; *b*, part of spinal column; *cc*, costal cartilages; *d*, ribs; *ee*, floating ribs

What causes the diseases that attack the lungs? Generally, when disease germs (minute living bodies) attack a healthy lung they are overcome and destroyed by natural enemies which nature has put into the blood and thus into the lungs. These enemies of the germs are

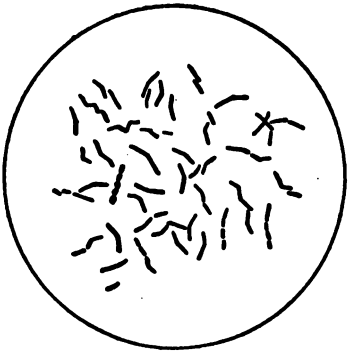
principally the white *corpuscles* of the blood. For a long time the function of these corpuscles was unknown. But it is now known that these little white particles, as distinguished from the red particles which give the blood its color, are police health officers. They are on duty to guard against all the thieves and robbers, the disease germs which strive to break into the body.

So long as we are well nourished and are living in sanitary surroundings these policemen are able to protect us against the bad germs which produce disease. On the other hand, when we are "run down," that is, when our vitality is lessened, when our food is poor or insufficient in quantity or not properly cooked, or when it is not properly chewed and digested, then we find that the white corpuscles are less numerous and are not so vigorous. These policemen, in other words, "go to sleep on their beats" and the thief and the robber germs enter the body and produce infection or cause disease.

Thus we are apt to have pneumonia when we are weakened by a cold, although the particular germ which causes the pneumonia is independent of the cold. The pneumonia germ is almost always present in the mouth, but it does not produce pneumonia until the vitality (resistance) of the body is lowered.

Tuberculosis, that most dreaded of all

diseases, is produced by a certain germ called *tubercle bacillus*, which enters the lungs through the blood or through the air. It finds lodgment in the weak or less vital parts of the lung, grows and increases in numbers, and gradually produces the tubercles which absorb, destroy, and slowly take the place of the lung tissues used in breathing. Tuberculosis kills more people than any other single disease. Statistics show that out of every one hundred people who die, eleven die from this disease.



Tubercle bacilli

How can the diseases which attack the organs of breathing be prevented? Diseases can be prevented, first of all by always breathing pure air; second, by keeping the body well nourished; third, by taking precaution to prevent the spread of tuberculosis germs. When there is a case of smallpox in a community the patient is taken to a special hospital and separated from the community until he gets well. But this is not always done when there is a case of tuberculosis. A patient suffering from tuberculosis walks the streets, rides in street cars and railroad trains,

sits at the table in public restaurants, and in general mingles freely with the public, all the while spreading germs which threaten his fellow-man.

The germs of tuberculosis are also present in the milk of tuberculous cows. Tuberculosis in cows differs somewhat from the tuberculosis that attacks human beings. Although the germ is different to a certain extent, yet it has been proved conclusively that the tuberculosis of the cow may be reproduced in human beings, and especially in children. The extermination of tuberculous cows would do much toward diminishing the possibility of spreading tuberculosis.

If we could induce the people who have tuberculosis to live by themselves until they are well, and if at the same time we could destroy all tuberculous cows in the country, we should be protected to a great degree against that disease. Instead of eleven out of every one hundred people dying from tuberculosis we might reduce the number greatly. Moreover, if we could look forward to days of perfect cleanliness of the air and of our food, we might even look forward to the day when tuberculosis would be completely wiped out.

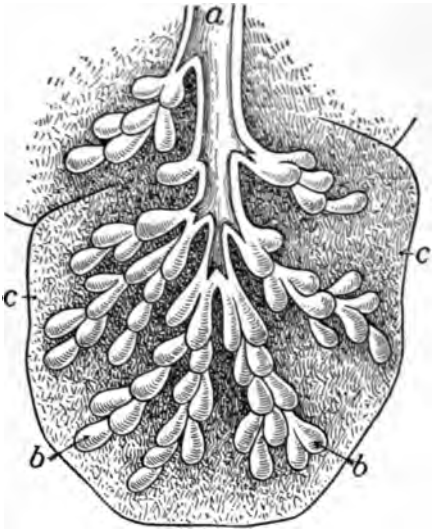
Your city and state boards of health would gladly undertake to get rid of tuberculosis and

all other dreadful diseases, but they do not always have the power and the money needed to do this.

The germ of pneumonia exists chiefly in the mouth. Therefore the mouth should be carefully cleaned at least three times a day, occasionally using a tooth paste that will help purify and clean the teeth. Rinsing the mouth with a sip of dilute hydrogen peroxide, or using an antiseptic spray, such as a mixture of odorless petroleum, eucalyptus oil, and menthol, will also do much to keep this threatening germ out of the mouth. In addition to these everyday precautions special care should be taken when you have a cold to keep the mouth free from infection and also to prevent unusual exposure to bad weather. At the same time particular care should be taken to keep the living-room temperature below seventy degrees and the air in the room perfectly fresh. With these precautions, a well-balanced diet, and plenty of sleep, you will be able to avoid an attack of pneumonia, a disease which kills almost as many people as tuberculosis.

What is the difference between the right lung and the left lung? The right lung is not shaped exactly like the left lung because of the position of the heart, which is placed more to the left than to the right side of the thoracic cavity.

The right lung is divided into three parts by deep clefts in the lung substances, although these parts are connected with each other so as to form one single organ. These divisions in the right lung are called the upper, the middle, and the lower lobe. The right lung is one or two inches shorter than the left lung because of the fact that the liver lies just below the diaphragm on the right side and pushes the diaphragm up against the lung.



A lobule of a lung
a, small bronchial tube; *bb*, air cells; *c*, lung tissue

The left lung is smaller and narrower than the right lung, but it is longer, and has only two divisions, the upper lobe and the lower lobe. It is a fortunate thing that the lungs are divided into lobes, or parts, by deep clefts. In pneumonia, for instance, usually only one of these lobes is attacked. If there were no lobes in

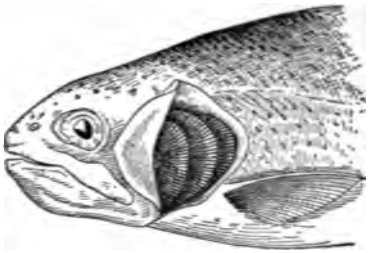
the lungs an attack of pneumonia might affect the whole lung. The physician is always hopeful of a recovery if he can confine the pneumonia to a single lobe.

How does a fish breathe? You have been told that any one who cuts off the air from his lungs by putting his head under water will drown. Now, although fish have their heads under water most of the time, and though the same oxygen that purifies your blood purifies the blood of the finny tribe, still they do not drown. How then does the fish breathe?

The water in contact with the air absorbs some of the atmosphere, including all of the gases. Naturally the water near the surface is more nearly saturated with air than the water farther down. It is also clear that if the surface of the water is roughened by the wind, or splashed in any way, it comes in contact with greater quantities of air and absorbs more of it than if the surface were quiet. A fish breathes by drawing this absorbed air out of the water near the surface.

Some of the animals that live in the water come to the surface to breathe above the water. The whale, for instance, which is not a fish, breathes in a great deal of air and blows it out again when it spouts. Some fish jump into the air and thus have a chance to breathe the air

above the water. In general, however, fish breathe by extracting the oxygen absorbed by the water which comes in contact with the open air.



Head of trout, showing gills

The fish, by the movements of its gills, which are its lungs, causes a large quantity of water to pass through and over them. The air contained in the water is absorbed into the gills of the fish.

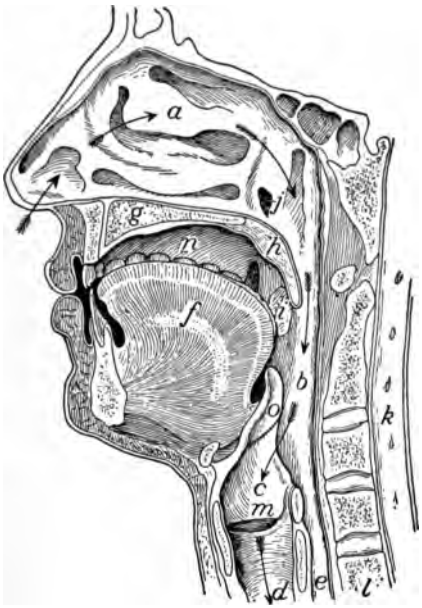
So, as long as the water contains air, the fish is able to keep its head under water. But if the water is covered with a sheet of ice, and does not come in contact with the air, the air absorbed in the water will gradually be used up. Then the fish will suffocate. You may have seen in the spring a pond full of dead fish. They have been suffocated because ice entirely covered the water during the winter and kept them from coming in contact with the air. If there is a hole in the ice fish will seek it in great numbers, rising to the surface in order to get the oxygen that has entered the water. Thus we see that fish, if kept in water from which the air is excluded, would be suffocated just as human beings are suffocated by putting the head under water.

How does air enter the lungs? The air enters the lungs either through the mouth or through the nostrils. The nostrils are the natural breathing tubes or pipes and should be used for breathing at all times, except perhaps when one is talking or singing. Especially in sleep should the breathing be done through the nostrils.

The tube or canal in each side of the nose is not perfectly straight. The air in passing through the nostrils thus comes in contact with the moist membranes which line them. Particles of dust and other matter in the air are caught and held by the moist walls. They are thus prevented from entering the lungs. The membrane lining the inside walls of the nostrils is moistened by mucus and is called a mucous membrane. Thus the air that enters the lungs through the nostrils is freer from dust particles and is cleaner than that which enters through the mouth.

The cavity of the mouth. The mouth is one of the most important parts of the body in relation to health. In the mouth are the teeth, by means of which the food is masticated. It also contains the tongue, which carries the nerve of taste. Without our tongues we could make noises, but we could not pronounce words. The tongue also has important functions besides that of speech. By its aid the act of swallowing

is started. Then, too, the walls of the mouth contain the openings of the glands which secrete the saliva, so important in keeping the mouth moist and so useful in the chewing and swallowing of food.



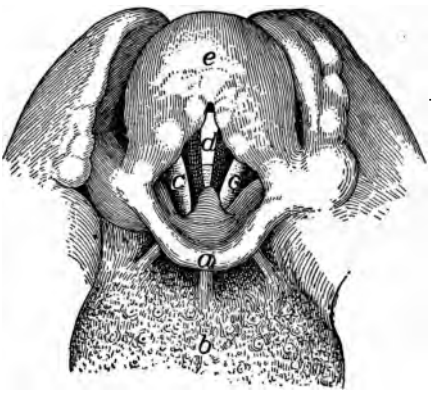
Air passages of head and throat

a, nasal cavity; *b*, throat; *c*, larynx; *d*, trachea or windpipe; *e*, esophagus; *f*, tongue; *g*, hard palate; *h*, soft palate; *i*, tonsil; *j*, opening of Eustachian tube; *k*, spinal cord; *l*, spine; *m*, vocal cords; *n*, roof of mouth; *o*, epiglottis; ⟶, passage of air through head to lungs

The lower part of the mouth is hinged near the ears and is movable. It can move up and down and sideways, thus aiding in the grinding of the food between the teeth, which act as upper and lower millstones.

Back of the mouth are the *tonsils*, and farther down are the *trachea* or windpipe, through which the air is carried to the bronchial tubes and thence into the lungs, and the opening into the tube—the *esophagus* or gullet—through which our food is conveyed to the stomach.

How does food enter the esophagus, and how does air enter the trachea? Why does not the food we swallow go into the lungs, and why does not the air go into the stomach? The answer to these questions is extremely simple. The upper part of the trachea or windpipe is called the *larynx*. The opening into the larynx is covered by a movable hinged lid called the *epiglottis*. When we are about to swallow food the epiglottis closes so that the food slides over the top of the windpipe without entering. All of the food is thus carried to the esophagus.

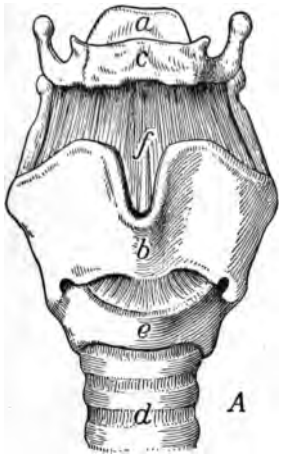


The epiglottis
a, epiglottis; *b*, tongue; *c*, true vocal cords; *d*, false vocal cords; *e*, cricoid cartilage

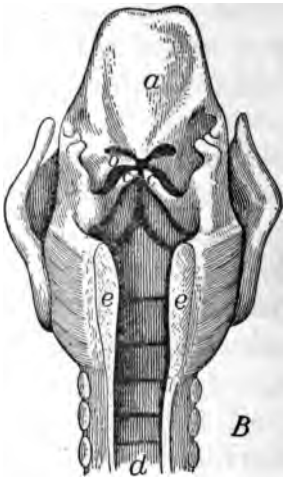
If by any accident the epiglottis should remain open and a particle of food should enter the larynx, violent coughing would result. This is nature's effort to throw out the offending body. If water or other liquids that we are drinking should enter the larynx there would be similar efforts to get rid of them.

The upper part of the trachea, as we have

learned, is called the larynx. The larynx is composed of a series of *cartilages* or flexible tissues midway between muscle and bone. Within it lie the vocal cords, two strong, fibrous bands covered by a thin layer of mucous membrane. They are of a light yellow color, very



A, Larynx, front view
a, epiglottis; *b*, thyroid cartilage; *c*, hyoid bone; *d*, trachea; *e*, cricoid cartilage; *f*, hyoid membrane



B, Larynx, posterior view
a, epiglottis; *b*, false vocal cords; *c*, true vocal cords; *d*, trachea; *e*, cricoid cartilage

elastic, and so arranged that they may be brought close together, or tightened or loosened, thus changing the tone of the sound produced. These changes are brought about by the numerous muscles in the larynx. If the trachea and bronchial tubes represent an inverted tree, then the larynx represents the root of the tree. It

is of great importance to keep the larynx in a healthful condition if the voice is to be preserved.

The air breathed out from the lungs causes the vocal cords to vibrate, thus producing sounds. If we had no vocal cords, or if they should become useless, we could not utter a sound, and the tongue, teeth, and lips would be deprived of sound material out of which to make words. If the vocal cords become inflamed, as in sore throat, they often become impaired or useless, and we are hoarse or speechless as long as the inflammation continues.

The cover of the larynx, that is, the epiglottis, protects the lungs and at the same time prevents any foreign matter from clogging the vocal cords. The vocal cords are stretched like the strings of a violin. They vibrate as the air passes over them, and a sound is produced when these vibrations are transmitted through the air. If the vocal cords are short and tight the voice is high and shrill, tenor or soprano; if the vocal cords are long and loose the voice is low and deep, bass or contralto.

What is choking? Choking is the term applied to the condition produced when the larynx or trachea is closed to such a degree as to prevent air from passing through to the lungs. If you grasp your throat tightly with your fingers you cause the trachea to collapse. This closes the

passage through which the air enters the lungs. If you keep the trachea shut long enough you cause death by strangulation.

If you should try to swallow a large quantity of food at once, so large that it would not pass through the esophagus, it would stick in the esophagus, bulging it out. As the esophagus lies back of the trachea, this bulging out might also close the trachea. In such a condition you would choke to death. If, on the other hand, the food were lodged in the esophagus in such a way as not to close the trachea, you might not choke to death for a long while, and if the obstruction were removed probably no harm would result. If the epiglottis were open and food should enter the trachea, the food would close the opening to the lungs and quickly cause death. In a case where speedy death is threatened by choking in this manner, the person should be held head down and sharp blows given with the palm of the hand on his back.

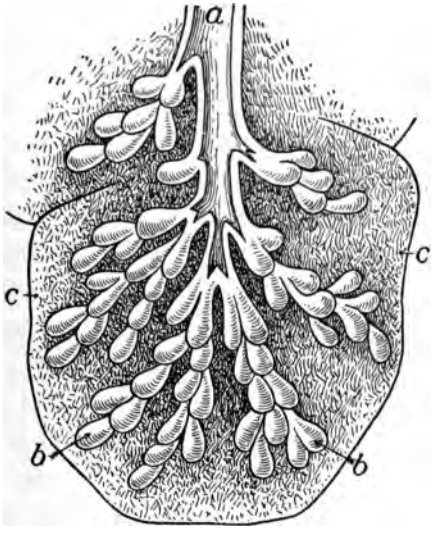
The palate. The roof of the mouth is called the *palate*. It is very hard and firm in the front part of the mouth. Toward the back of the mouth it becomes soft. In the middle of the soft palate at the back of the mouth hangs a small conical fold, which swings like a pendulum. This fold is known as the *uvula*. Sometimes the uvula becomes so long that it hangs

down and touches the top of the larynx, that part of the trachea holding the vocal cords. This produces a tickling sensation which induces coughing, and it is thus often troublesome to public speakers. In such a case it is a simple matter to seize the projecting point with forceps and cut off a portion of it. While this is a simple matter it should not be done by any but a competent surgeon, using sterilized apparatus so as to avoid every danger of infection or inflammation.

The tonsils. The *tonsils* are two glands at the back of the mouth which protect the body against germs. When the germs are so numerous that the tonsils cannot destroy them all, the tonsils become infected, especially in children. It is advisable in such cases, especially when the tonsils are enlarged, to have them removed by a surgeon.

The pharynx. Back of the mouth is the *pharynx*. This cavity extends upward back of the soft palate and is bounded above by the lower wall of the framework inclosing the brain, and below by the beginning of the esophagus. In grown persons it is about four inches long. It is a kind of meeting place for various roads. The two principal roads opening into the pharynx are the mouth and the nasal passages. But there are other paths of very great importance

The right lung is divided into three parts by deep clefts in the lung substances, although these parts are connected with each other so as to form one single organ. These divisions in the right lung are called the upper, the middle, and the lower lobe. The right lung is one or two inches shorter than the left lung because of the fact that the liver lies just below the diaphragm on the right side and pushes the diaphragm up against the lung.



A lobule of a lung
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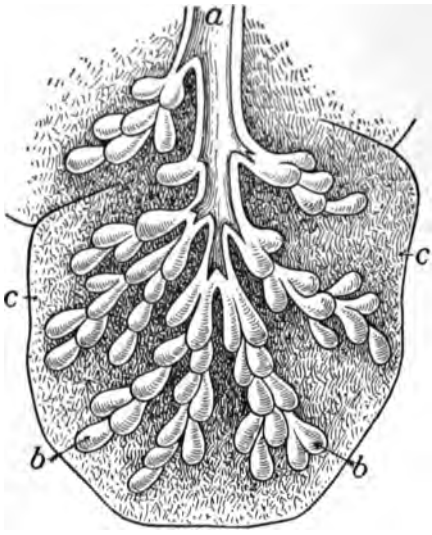

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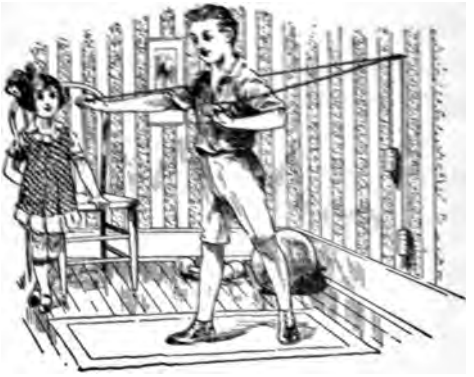
are usually very severe on a particular set of muscles. Unlike outdoor play they do not require the use of all the muscles. It must be remembered, too, that even in the best ventilated rooms the air is not so pure as it is in the open. In addition to this, indoor play lacks the benefit that is derived from the sunlight.

Children at play in the open air

Games should be a part of education. Learning to play properly is quite as important as learning other lessons. The most important thing of all is to learn the rules of health and make them practical by obeying them. In the freedom of outdoor play the lungs are filled with air naturally and without conscious effort on the part of the child.

Outdoor play does more good than exercises given for a special purpose. The mental state in outdoor play favors better results than are possible in indoor play. Outdoor exercise affords an excitement and an attractiveness which can never be equaled by anything within four walls. On the whole, then, outdoor play is greatly to be preferred to indoor exercise.



A helpful indoor exercise

How can play influence the organs within the thorax? All kinds of play increase the rapidity of the heart's action, and thus directly affect the organs inside the thorax. Since the blood runs directly from the heart into the lungs, whence it is to be sent back to the heart and then distributed throughout the body, there is a close relation between the action of the lungs and the action of the heart. As the blood circulation increases in activity the breathing becomes deeper and more frequent. The lungs expand and respond at once to the increased

activity of the circulation. Thus all kinds of properly conducted play or exercises are a benefit to the lungs and the heart.

In general, it may be said that exercises in which the arms and shoulders are used are especially helpful to the heart and lungs. The simple exercise of stretching both arms up over the head and holding them there for a short time may be practiced methodically. Bringing the arms down slowly, straight out from the shoulders and with fingers clinched so as to make the muscles tense, is also very helpful. The swinging of the hands backward, at first slowly and gently and then more vigorously until the backs of the hands touch, is another helpful exercise. The circular movement of the arms around the shoulder as a pivot, throwing the head back and pressing out the throat and the top of the chest, is also a good exercise. Stooping over and touching the floor with the fingers without bending the knees, bending back as far as possible, and bending the body to each side gently but firmly as far as you can, develops the muscles of the ribs and abdomen and increases the ability of the organs of breathing to do their duty. In all these exercises deep breathing and an occasional holding of the breath for a few moments to expand the lungs will be of benefit.

Indoor exercise with dumb-bells is also helpful and greatly strengthens the muscles of the shoulders, arms, and thorax. The dumb-bells used should be light at first, but gradually the weight may be increased as the strength of the individual permits. Swinging by the hands, climbing a rope with the hands and legs, and other exercises of like kind increase the breathing capacity. All of these exercises should be taken under the direction of a competent director, so that they may be effectual and so directed as to avoid harmful results. Playgrounds of the right kind for the development of a good physique, so necessary for efficiency in later life work, are quite as important as good schools and useful employment, if not more so.

What causes a cold? Most people think a cold is caused by a draft of air. If this were true everybody who goes outdoors, except on days of calm, would be in danger of taking cold. On the contrary, colds are nearly always produced by remaining in an overheated room in a stale atmosphere. If you have become very warm from vigorous exercise or work, and then sit down to rest where it is cool, your body may be cooled so rapidly as to drive the blood from the skin and also harm the internal organs. Then you have caught a cold. Mere changes of temperature, however sudden they may be,

do not cause a cold unless certain cold-causing microbes start to grow in the body.

Can you catch a cold from another person? Yes, this is perhaps the most common way we get a cold. Somebody with a cold scatters the germs abroad and these, when breathed in, attack other persons, who then fall ill.

Sneezing is a source of danger to persons near by

Why does not everybody who is exposed to such infection fall ill? If the body is well nourished, if it has been supplied with pure air, if all the organs are in good condition and you are very healthy, you will be able to resist the cold-causing microbes. But if you are run down, poorly nourished, or very tired, your vitality is so low that it will not resist the microbes, and you become ill.

What makes a person who has a cold sneeze? Sneezing is a sudden contraction of the muscles

which control the expelling of air from the lungs. By this contraction the air is forced in a sudden puff through the nostrils or the mouth. The nerve causing this action is affected by an irritation in the nostrils or in the throat, and the sudden clearing of the air passages, by sneezing or coughing, is nature's way of getting rid of the irritation.

Is sneezing a source of danger to persons near by? Yes. In sneezing, the particles ejected from the nostrils or the mouth may be thrown to a great distance, and these particles may be the carriers of infection. Never go near a person with a cold. Never kiss anybody who has a cold. If you can avoid it, never stand near a person who sneezes when he has a cold. To prevent others from becoming infected, one should always hold a handkerchief over his mouth and nostrils when he sneezes.

Should children with colds go to school? No. Children and grown people afflicted with colds should not go to school or into any public hall where lectures, plays, or religious services are carried on. Persons with colds should be kept at home, quarantined if necessary, until the danger from infection has passed. The air about a person who has a cold necessarily contains a great many germs thrown out by coughing and sneezing, and persons near by are in constant danger

of breathing the infected matter into their lungs. The medical inspector or teacher should stand at the schoolroom door every day and see that no person having a cold enters the schoolroom.

Spraying the throat for a cold

Are there other places where the air may carry danger of infection from colds? Yes, many. Among the more common places of infection may be mentioned crowded cars — especially in winter, when doors and windows are closed — churches, theaters, moving-picture shows, and public meeting places of all kinds where large crowds gather in a small space. Children and even grown people often contract dangerous diseases in these crowded places from breathing air which carries the germs of colds or other diseases.

Are colds dangerous? No, colds in themselves are not as a rule dangerous. But a person afflicted with a cold easily contracts a more serious disease; indeed, he is much more likely to do so than when in good health. Such

diseases as the grip, diphtheria, scarlet fever, measles, whooping cough, smallpox, and especially pneumonia, one of the most dreaded of all diseases, may follow a severe cold.

What is good for a cold? Rest, pure air, good food, a soothing antiseptic sprayed into the nostrils and throat, and proper attention to the bowels are helpful in overcoming a cold.

QUESTIONS TO HELP THE PUPIL

1. What happens when you breathe the same air over and over again? 2. What are the white corpuscles and how can we aid them in their work? 3. What care should be taken to prevent tuberculosis? 4. What precautions should we take to prevent pneumonia? 5. Why should we breathe through the nose and not the mouth? 6. Why is outdoor play beneficial? 7. What should be the temperature in all schoolrooms? 8. What exercises are good for the organs of breathing? 9. What causes a cold? 10. May we catch a cold from other persons? 11. What is good for a cold?

12. What are the lungs and in what part of the trunk are they placed? 13. What structure of bones incloses them? 14. What is the trachea? What are the bronchial tubes? 15. To what can the lungs be compared? 16. What is the pleura? 17. How do the ribs and the diaphragm move when a person breathes?

18. Describe the heart and tell of its work. 19. Describe the blood's journey from the auricles to the lung cells. 20. What is the color of the blood when it reaches the lung cells? When it passes out? 21. What does the blood bring from the tissues to the lung cells? What does it carry back? 22. What have you now learned is the purpose of breathing? 23. How can we show that there is water in the breath? 24. How can you show that there is carbon dioxide in the breath? 25. How are the lungs protected from the pressure of the

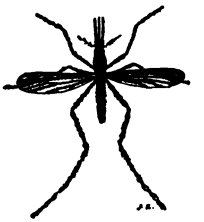
atmosphere? 26. What is the sternum? 27. Are the right and left lungs alike? 28. Can a fish breathe in water? Why? 29. What is the purpose of the saliva glands opening into the mouth? 30. What is the esophagus? 31. What is the larynx? What keeps food from entering the larynx and the trachea? 32. What are the vocal cords? 33. How are sounds produced? 34. What would happen if food should lodge in the trachea or stick in the esophagus? 35. What is the palate? 36. What is the uvula? 37. What is the pharynx? 38. What opens into the pharynx besides the mouth and the nasal passages? 39. What are the Eustachian tubes?

IV. How Mosquitoes and Flies Endanger Health

Are mosquitoes a menace to health? The results from the bites of some kinds of mosquitoes may be very serious. The *Culex* or ordinary mosquito does no special harm, except that it raises a lump with an itching sensation and withdraws a drop of blood. If you were stung by enough mosquitoes you might die from loss of blood, yet the ordinary mosquito would not leave with you the germs of any disease. But in many parts of the country there is one species of mosquito that is especially dangerous. You have all heard of chills and fever. The common name of this disease is malaria. It was so called because of the mistaken supposition that the chills and fever are caused by bad air. That is what the term "malaria" means. But we know now that it is not bad air nor night air that causes malaria. This disease is caused by the bite or sting of a mosquito, not the common kind, but a kind which is widely distributed.

The mosquito that conveys what is called malaria is the *Anopheles*. When biting or stinging, the Anopheles mosquito assumes a position quite different from that of the C[illegible] To stick her bill into the back of your ha

Culex stands up in a decent way and bends her head down. The Anopheles, on the contrary, seems to stand on her head so as to give more punch to her entering bill. Then there is the *Stegomyia*, another kind of mosquito which does not bother us except occasionally in the extreme southern part of our country. This variety of mosquito carries that dreaded disease, yellow fever.



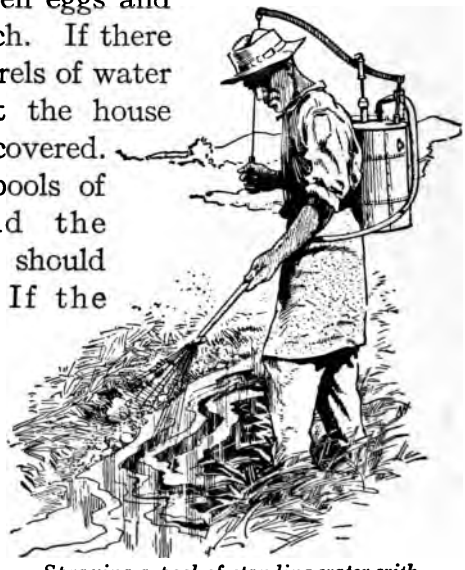
The mosquito which causes yellow fever

Neither the Anopheles nor the Stegomyia is dangerous in itself, but if an Anopheles stings a person who has malaria the germs or parasites of malaria are developed in this mosquito and are then transmitted to the next person she stings. The same is true of the Stegomyia. If she stings a person who has the yellow fever and then stings another person who has not the fever she conveys the yellow fever parasite to that person. In this way both malaria and yellow fever are spread.

What is the proper method of protection against these diseases? If possible, kill the mosquito. If this cannot be done screen yourself from mosquitoes. In a country where mosquitoes abound, no person should sleep in a place where windows or sleeping rooms are not carefully screened. In the daytime you can

usually protect yourself from the mosquito, but at night you fall an easy victim to her. It does not cost much to put mosquito netting around any place where you are sleeping. The one who does not take this precaution is very likely to be stung and suffer from the consequences.

What is the best way to get rid of mosquitoes? It is useless to try to kill all the mosquitoes. But it is easy to prevent their breeding. There should be no pools of water left where mosquitoes can lay their eggs and have them hatch. If there are tubs or barrels of water standing about the house they should be covered. If there are pools of water around the grounds these should be drained. If the swamps are too big to drain, the mosquitoes may be prevented from laying and hatching eggs by pouring a little petroleum or coal oil on the water. The coal oil spreads in a thin film over



Spraying a pool of standing water with petroleum

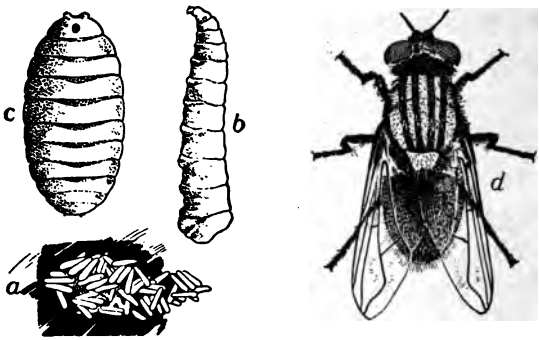
the surface of the water and prevents the development of the mosquito eggs. Large areas, as in Cuba and the Panama Canal Zone, have been freed from mosquitoes by taking this precaution.

What is good for the bite or sting of a mosquito? From his personal experience, Doctor Howard, Chief of the Bureau of Entomology, says the most effective remedy is moist soap. Take the end of a piece of ordinary toilet soap, rub it gently over the puncture, and the irritation will soon pass away. Others enthusiastically recommend household ammonia, alcohol, glycerin, or peroxide. Holding the hand near a hot lamp chimney has also been found to give relief.

What is the relation of flies to ill health? Flies bear a very important relation to health. The fly is really the creature of filth. The eggs of the fly are laid in manure or filth of some kind, where they are hatched into maggots that remain in the manure until they pass into their *pupa* or inclosed stage, from which they presently come out as flies. Flies constantly visit every spot where manure or other filthy material is to be found. They go from the kitchen and dining room, where they are polluting the food, to the stables and outhouses to lay their eggs, and then back again, bringing impurities to

the food supplies. It is believed that typhoid fever, diphtheria, and other infectious disease germs are very commonly carried by flies.

What is the best way to prevent flies? Cleanliness about the house, the outhouses, and the



The life of a house fly
a, eggs; *b*, maggot; *c*, pupa; *d*, full-grown fly

barns is the first requisite for success in the fight against flies. So, first of all, it is important to remove the filth in which the fly lays its eggs. It is estimated that one fly will lay one hundred twenty eggs. In from one to ten hours these eggs hatch into little white maggots. And within four or five days a maggot gradually turns into a fly. Then in about four days the fly is full grown and ready to start out on its errand of producing more flies. Thus one fly will, in the course of a week or ten days, produce one hundred twenty flies. Thus you see in a

very little time one fly can boast of a million descendants.

As flies cannot be entirely prevented from breeding, the next best thing is to keep them out of the house—out of sleeping rooms, kitchen, and dining room. This is most easily done by screens. The doors leading out of the house should have double screens, to prevent the flies getting in when the doors are opened. Any fly found in a room should be killed immediately. The fly swatter is the advance agent of good health. "If at first you don't succeed, swat, swat again!"

QUESTIONS TO HELP THE PUPIL

1. What three kinds of mosquitoes are there? 2. Do ordinary mosquitoes carry disease? 3. How can we guard ourselves against mosquitoes? 4. How did the Americans fight mosquitoes in the Panama Canal Zone? 5. What is good for the bite of a mosquito? 6. How do flies carry disease? 7. What are the best ways to get rid of flies? 8. What is a fly swatter? Why should we use it diligently?

V. Dust in the Air

What is it we see when a ray of sunlight enters a room, making a straight, shining streak? We see fine particles of dust which are invisible until lighted up by the ray of sunlight.

Is there usually much dust in the air indoors? Yes, there is, and also dust in the air in most other places. The dust indoors, however, is more injurious than the dust in the air outdoors. One should live as much as possible in the open air.

Stirring up dust with a broom

Does sweeping make more dust? No, sweeping does not make dust; it only stirs up the dust that has gathered on the floor and sends it flying in the air again.

What is dust? Dust consists of particles or tiny bits of various substances, the particles being so fine and so light that when once started in motion they float in the air for a long time.

If you stir up some clay in water all the large

particles will soon settle at the bottom, but the clay dust remains suspended in the water for many hours and even for days. In the waters of the Missouri River the clay dust never settles. They are always muddy. In like manner dust particles float a long time in the air.

Can you get the dust particles out of water? Yes. If you mix a little lime water or a weak solution of alum with muddy water it will become clear in a short time. Substances like these cause the fine particles of clay suspended in the water to come together and form larger particles, which sink. Just so dust particles cling together and then sink in the air.

What results from the entrance of dust particles into the lungs? The dust particles often stick to the moist surface of the lung cells, causing irritation and injury. People who continually breathe air containing large numbers of carbon particles such as are present in the smoke from burning soft coal, often have black deposits of carbon in their lung tissues. Although it is not possible to find an atmosphere entirely free from dust, it is important to avoid, as much as possible, breathing dust-laden air.

How does dust get into the air? Dust is sent into the air by moving bodies in contact with the surface of the earth, especially when the ground is dry. A horse, wagon, or motor car

in motion will cause dust to rise from the ground. But the wind probably does more

A cloud of dust caused by a motor car

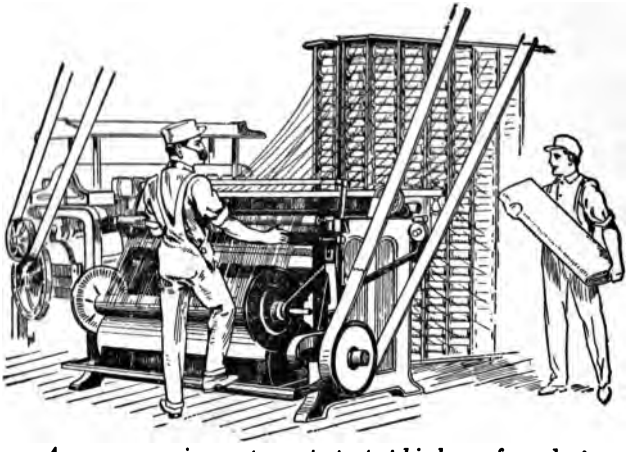
to keep the air full of dust than any other moving body. It lifts the dust from the earth's surface, and the harder it blows the more difficult it is for the particles of dust to fall to the ground again. In many parts of the world, especially in deserts and dry regions, dust and sand storms are much feared. Sand storms and snow blizzards are much alike. In each case fine particles are carried through the air at a high rate of speed, so blinding the traveler that often he loses his way. Sand storms are common in the deserts, and snow blizzards in the northern, central, and western parts of the United States.

How may those who must breathe a very dusty atmosphere protect their lungs? People who work in a dusty atmosphere may protect their lungs by placing a moist sponge over the nose and mouth. In passing through the sponge the dust-laden air strikes the moist walls of the sponge cells or spaces and the dust particles settle and remain there. From time to time the sponge may be washed and then it is again ready for use. Threshing grain is dusty work, and farmers using threshing machines find wearing a moist sponge a great protection. Workers in cotton mills also find the sponge a protection

A sand storm in the desert

against the lint and dust that fill the air in factories and mills.

What care should be taken to lessen the amount of dust in houses? Houses should be built with smooth walls. Carved or irregular walls and ceilings provide places where dust may gather, and from which it is easily brushed off and set in motion by opening doors and windows and by "dusting." There should be no projections, moldings, or corners where dust may gather. Such things as mantels, picture frames, and clocks should be frequently cleaned with damp cloths. The moisture in the cloth takes up the dust that has collected without causing it to start sailing through the air in the room. Floors should be smooth and without cracks. There should be no carpets, and rugs should be cleaned frequently. The best broom is a



A weaver wearing a sponge to protect his lungs from dust

vacuum cleaner. This appliance or household aid takes up all dust. Even carpets are harm-

Cleaning a rug with a vacuum cleaner

less if frequently cleaned with a vacuum cleaner.

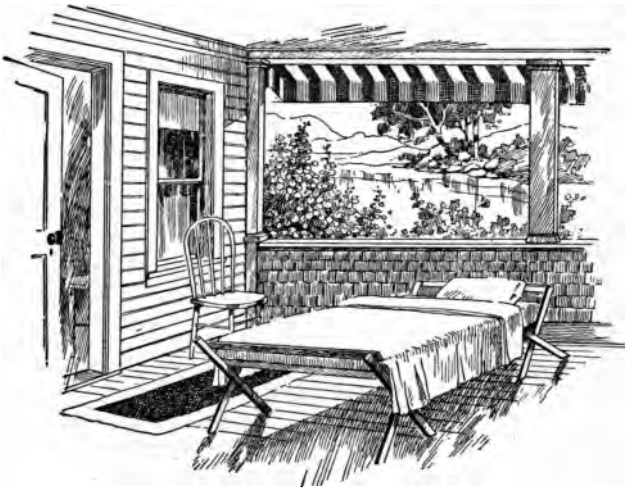
What is the danger from dust in the house? Disease germs are likely to be present in the dust, if there have been sick people in the house. The germs of tuberculosis, in particular, are likely to be present in house dust for some time if persons afflicted with this disease live in or visit the house. The sputum (spit) containing the germs dries rapidly, and the germs float in the air like small dust particles. When lodged in the cells of the lungs these dry germs, if of recent origin, may become active again and thus start the disease that causes more than one tenth of all deaths. Tuberculosis is

sometimes called a "house disease." If everybody lived out of doors there would be very little tuberculosis.

Are the germs of tuberculosis spread about in any other way than through the air? Yes, tuberculosis germs are spread about in many different ways. The infection may come from direct contact, as in drinking from a cup that has been used by some one suffering from the disease. It may also be caused by eating food from dishes which have just been used by consumptives, or by drinking the milk of tuberculous cows. A person may also get tuberculosis from eating the unsterilized meats of tuberculous or infected animals, especially cattle and hogs. These are but a few of the things which cause infection.

How can we be protected from these dangers? We can best protect ourselves by spending as much time as possible in the open air. While disease germs may be present in the air currents out of doors, because consumptives have been spitting in the street or for other reasons, the danger of inhaling these germs is comparatively slight because of the great quantity of air in which they are carried. On the other hand, the air indoors is breathed over and over again, and even if there were but a few dangerous germs in the room, the chance of breathing

them in is very great. In addition to spending as much time as possible outdoors during the day, a good way to prevent this disease is to sleep on a porch at night. Children especially should sleep in the open, for it is often in infancy and childhood that this disease takes hold. The



A sleeping porch. People who sleep in the open air usually are free from disease

germs that develop into tuberculosis in persons who have reached twenty-five or thirty years of age often enter the lungs during childhood, and their presence is not discovered for many years. People who live and sleep indoors, in rooms that are poorly ventilated, offer the most favorable conditions for the development of the disease.

Is there any danger in sleeping out of doors? As a rule, there is none whatever. In pleasant weather one may sleep on the ground with an oilcloth blanket under him and a blanket over him. If it rains he should, of course, have some kind of protection, such as an oilcloth covering, to keep him dry. People who live out of doors, play out of doors, and sleep out of doors rarely have colds or tuberculosis or diseases of the throat.

QUESTIONS TO HELP THE PUPIL

1. Is there much dust in the air everywhere? 2. Why should we live as much as possible in the open air? 3. What is dust? 4. Do dust particles remain in the lungs? What is the result? 5. What is the cause of dust in the air? 6. How should persons working in a dusty atmosphere protect their lungs? 7. What care should be taken to diminish the amount of dust in the house? 8. What is the danger of dust? 9. What is tuberculosis sometimes called? 10. In what other ways than through the air are the germs of tuberculosis carried about? 11. What is the best way to protect ourselves from these dangers? 12. How can we protect ourselves from the weather when sleeping out of doors?

VI. A Study of Ventilation

What is ventilation? "Ventilation" is the term applied to the circulation of fresh air through rooms in which people live, sleep, and congregate. In a well-ventilated room the air is so frequently or continuously changed as to prevent it from becoming stale or contaminated and a danger to health.

Why is ventilation necessary? Air at rest becomes stagnant in the same way that water at rest becomes stagnant. So it is desirable to keep it in constant motion. This may be done either by mechanical means—as, for instance, by an electric fan—or else by taking advantage of the tendency of heated air to rise and thus cause movements of the whole air mass.

Air confined in a room is usually of a different temperature from that of the air out of doors. It may be warmer or colder. As a rule, air indoors tends to be warmer than outdoor air. Thus, if a flue opens into the room, the tendency of the confined air is to pass up that flue. Then air of a different character will enter through various openings, such as the cracks under the doors and around the windows, or other ventilating spaces, and take the place of the air that has passed up the

flue. If there is a chimney and fireplace in the room the chimney itself becomes a ventilating shaft through which the warm air escapes.

Entering a room in a building which has been kept tightly closed, you at once notice the difference between the stagnant air of that room and the air in rooms where the doors and windows are open at all times and the air is kept in constant motion. Thus we see the first principle of ventilation is to prevent the air from becoming stagnant.

How does the air become contaminated? In a room tightly closed, which has in it no source of contamination, air would not change in character even if it became stagnant. But in living rooms, or in rooms where people sleep or congregate, the air is constantly used in breathing. We have learned that the air which is expelled from the lungs is of a different character from that which is taken into the lungs. Now if we regard the air that enters the lungs as pure, then the air that is expelled from the lungs is impure. This impure air breathed from the lungs mixes with the pure air in the room and gradually the whole mass of air about us becomes impure or unclean.

The smaller the room space or the greater the number of people gathered therein, the more

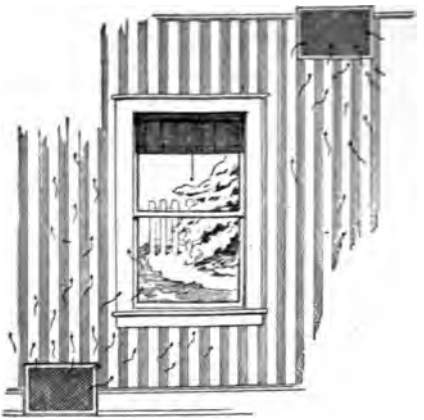
rapidly will the air become impure or harmful.

If gas jets or oil lamps are burned in a room a similar change takes place in the air. The flame of the lamp or the gas is fed by the air. The air that is used by the flame may be regarded as pure, but the air that comes away from the flame is impure. Moreover, if there are living beings in the room they are constantly throwing off impurities into the air.

Thus the air in a confined space where living bodies are present, or where oil lamps or gas jets are burning, and where there is no provision for a rapid change of the air, becomes continually more and more impure. Also, if cooking is done in a living room, impurities rising from the foods being cooked tend to add to the impurities in the surrounding air. In order to secure the best conditions of health, the air in living rooms must be frequently and systematically changed.

What are the best methods of changing the air in a room? The influence of fireplaces and chimney flues and of cracks under doors and about windows has already been explained. Though not intended for that purpose, all these openings promote ventilation. In some dwellings and public assembly halls, however, apparatus is especially installed for ventilating purposes. Ventilating flues are placed in the walls when

the buildings are constructed. The size of the opening into the rooms may usually be adjusted by mechanical means, according to the needs of the space to be purified. These openings are generally called "registers." They may admit warm air or cold air, or they may lead off the impure air.

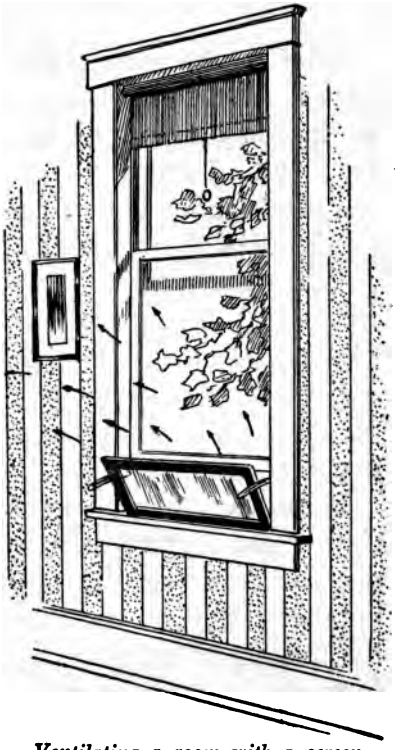


Forcing impure air out with registers

Ventilation is best regulated when mechanical ventilating appliances are used. Ventilating by mechanical means generally follows two methods: One method is to force fresh air through pipes into a room by machinery installed for that purpose, thus forcing the same volume of air out of the room. The other method is so to connect the ventilating flues with a suction fan as to draw or suck the foul air away. The ventilating machinery may be so arranged as to regulate the temperature also, by heating or cooling the air that is forced into the room.

Where no mechanical ventilators are installed

the doors and windows may serve. If the window is opened from the bottom, a plate of glass or a board should be used as a screen, in order to direct the air upward into the room and not allow it to flow straight in at the bottom. If two windows are used for ventilating purposes one should be opened at the bottom and the other at the top. Wire screens covered with cheesecloth placed in open windows are an excellent means of securing ventilation.



Ventilating a room with a screen at bottom of window

QUESTIONS TO HELP THE PUPIL

1. What does the term "ventilation" mean? 2. When is a room well ventilated? 3. Why is it necessary to change the air in living rooms? 4. Why is a burning lamp or gas jet in a sleeping room undesirable? 5. What is a "register"? 6. What methods are used in mechanical ventilation? 7. How should windows be opened for ventilation?

VII. A Study of Temperature

What is the most desirable temperature in a room? The temperature in a room in which work of any kind is carried on should not exceed sixty-eight degrees. This is the most favorable temperature for the best results and the highest efficiency of the worker.

When the temperature out of doors is below sixty-eight degrees the temperature indoors is kept up by means of fireplaces, stoves, furnaces, hot-water pipes, steam pipes, or by electric heating. All of these methods are good if properly regulated.

When the atmosphere outside is warmer than sixty-eight degrees there is no method in general use for reducing the temperature. The temperature may be reduced indirectly, however, by means of awnings which shield the room from the heat of the sun and thus tend to keep it comparatively cool. In some public halls artificial refrigeration is practiced. Air that has been cooled by passing over ice or over pipes filled with cold brine is forced into the room by means of ventilating appliances. This adds much to the comfort of the people in the hall, but the process is expensive and so it is not often used. Only wealthy people can

afford a machine of this kind in their homes. In other words, it really costs much more to cool the air in summer, with the appliances that are now available, than it does to warm it in winter.

However, so far as comfort is concerned, it is much more important to heat cold air than it is to cool hot air. If the temperature does not go above eighty-five or ninety degrees, worrying over hot weather causes far more discomfort than the hot weather. A natural temperature of from seventy to eighty or even eighty-five degrees causes no great discomfort to most persons. On the other hand, should the temperature of a living room fall to fifty or forty-five degrees, unless the people in the room are wearing very heavy outdoor clothing or are tucked in bed under warm blankets and quilts, they are extremely uncomfortable.

The evils of overheating. One of the common evils in the United States in cold weather is overheating. This custom prevails everywhere —in private houses, in schoolrooms, in churches, in public offices and theaters, in railway cars and street cars, and in fact everywhere that people gather. It is not unusual to find the temperature of a living room during the winter much above seventy degrees, and even as high as seventy-five and eighty degrees. This is

true also of schoolrooms, public halls, theaters, and offices. Sometimes in railway cars, especially in sleeping coaches, it is higher even than this.

Within the last few years there has been much improvement in this direction, although the evils of overheating are still common. A person is not only uncomfortable in an overheated room, but is in constant danger. Going out of doors into the cold air, he quickly becomes chilled and in that condition is an easy victim of colds, sore throat, bronchitis, and pneumonia. If the temperature in our rooms during the winter were never higher than sixty-eight degrees, there would be much less suffering from such diseases.

Why is the temperature kept so high? The practice of overheating is due to the mistaken notion that when indoors we should be very warm, especially if the cold outside is severe. The practice of keeping rooms too warm is strongly established. Many people would object to a temperature indoors as low as sixty-eight degrees. When there is more than one person in a room, as there usually is, they cannot always agree as to the most desirable temperature. One person wants a temperature of sixty-eight degrees, another of seventy, while others are not content with less than seventy-five

or eighty degrees. If there is no established regulation, the one who wants the most heat usually gets it.

In public buildings, schools, theaters, public halls, churches, street cars, railway cars, and similar places, the temperature should be regulated according to a fixed rule. The general public, moreover, should be taught to avoid the dangers of overheated rooms in the home. The living room should never be heated to a temperature of eighty degrees. But many mothers have never been so taught.

When the air out of doors is warmer than sixty-eight degrees, as it is sometimes early in spring and nearly always all through summer and a part of autumn, the windows should be opened wide, and also the doors, if that will help to let the breezes blow through the room. When the air is continually changed in that way it is surprising how easily we can bear a temperature above sixty-eight degrees. Anyway, a temperature that is high because of natural conditions, as it is in summer, does not threaten health. The air is pure, it is constantly changed, and it is not contaminated by the breath of people.

What are the chief obstacles to perfect ventilation? The first obstacle is ignorance of the principles on which ventilation is based.

second, the difficulties and the expense of changing the air in living rooms during the winter when the cold is intense. It is evident, therefore, that many of the evils resulting from poor ventilation, especially when they are due to cold weather, will continue for a long time without effective remedy. In short, one of the principal difficulties is the cold of winter. When it is cold many people think they cannot afford to open the windows in their living rooms, and frequently fail to do so in their bedrooms, much to their own discomfort and injury.

What should be the temperature in a bedroom? The temperature in a sleeping room should be much lower than that in a living room. In fact, the temperature in a sleeping room, except in very cold weather, should be the same as that out of doors. The windows and even the doors should be left wide open. Sleeping rooms, moreover, should never be heated by artificial means except in cases of extreme cold in high northern latitudes. Instead, there should be enough bed covering to keep the sleeper warm.

The bed should not be in the living room. Unfortunately, very poor people cannot always have both a living room and a bedroom. But wherever it is possible the bedroom should be separate from the living room, and it should not be heated above sixty degrees by artificial

means. The outdoor sleeping room or the sleeping porch is the ideal place to sleep, though it is not possible for everybody to have one.

When the children now growing up have learned the fundamental principles of ventilation, and know what the proper temperature of the air should be, a great change will take place in the homes of our people.

Why is air in motion more agreeable than air not in motion? Every one has noticed that when the air is motionless the high temperature of a summer day seems harder to bear than if a breeze is blowing, no matter how lightly. But the air in motion is not really cooler. It is the constant change in the particles of air that come in contact with the body that makes a person feel refreshed. In all living rooms and sleeping rooms it is important to keep the air in gentle motion, either by the natural process of ventilation or, in very warm weather, by means of an electric fan when available.

QUESTIONS TO HELP THE PUPIL

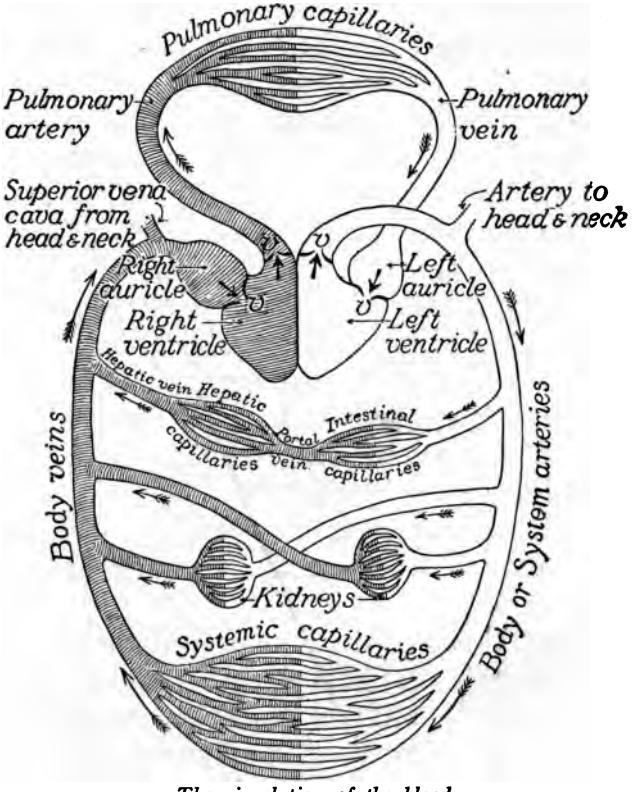
1. What has proved to be the most desirable temperature in a room where work is carried on? 2. By what different appliances may a room be heated in winter? 3. How may a room be kept cool? 4. What is the danger of keeping a high temperature in living rooms in winter? 5. What should be the temperature in a sleeping room? 6. Where is the ideal place to sleep? 7. Is air in motion really cooler than air at rest?

VIII. The Circulation

What is meant when we say that the blood circulates? In the human body the blood is in constant motion. This motion is produced by the action of the heart. The tubes through which the blood passes have been given three different names in different parts of their course. Those that convey the blood from the heart are called *arteries*. Those that bring it back are *veins*. Between the two are the *capillaries*, which are simply a very fine network of branches uniting veins and arteries. Altogether these blood vessels make a closed, branched sack, connected with the heart, which is in about the center of the circulatory system. Through the heart, arteries, capillaries, and veins the blood is continually circling throughout the entire body. The structure of the three groups of blood vessels is similar, but the arteries are largest; they also have thicker and more elastic walls. The veins have little valves or pockets on the inner sides of the walls to keep the blood from flowing backwards. The capillary walls are extremely thin.

This journey of the blood, from the heart over the whole body and back to the heart, is called the greater, or *systemic*, circulation. The

passing of blood to the lungs and back to the heart is the lesser, or *pulmonary*, circulation.



The circulation of the blood
v, valves to and from the heart; arrows indicate direction of circulation

What is the use of blood? The blood is the vital current that carries food particles to all the tissues of the body, each tissue selecting what it requires or needs. One tissue takes up

material to build bone, another selects material for muscle, a third takes up material to build the hair, a fourth to form the skin, and so on. All of these food materials are taken from the blood stream. The blood also carries particles of oxygen to the various tissues. It takes waste material away from the tissues, and carries it to those organs in the body whose function it is to separate and remove it from the body. These organs, chiefly the skin, lungs, and kidneys, are called the *excretory organs.*

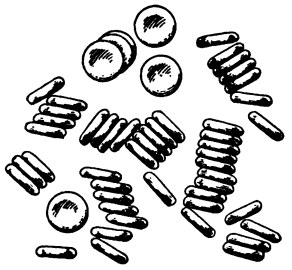
The blood also brings the carbon dioxide, which is produced by burning food and tissues, and water back to the lungs. There a large part of the water and some of the carbon dioxide leave the blood by passing into the air through the thin membranes of the small cells in the lungs. At the same time oxygen enters the blood.

What is true of the human being is also true of all animals that have blood. All the higher animals have a similar system of circulation, and for the same purpose, with only such variations as the different conditions in which they live have brought about. Without this circulation through the body, life would be impossible. Anything that impedes or prevents the circulation of the blood causes speedy death.

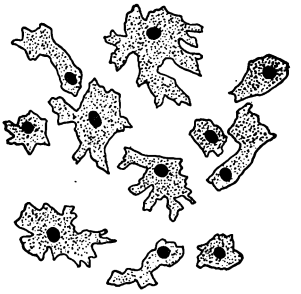
The red particles of the blood are minute

disk-like cells, called corpuscles. They carry the oxygen. They play very important rôles in nourishing and vitalizing the body. The red particles may thus be regarded as the most important constituent of the blood.

Are there any other particles in the blood? Yes, there is a very important family of particles in



Red corpuscles



White corpuscles

the blood, known as the white corpuscles. These are somewhat larger than the red corpuscles, and much less regular in shape. For a long time their particular function was unknown. You have already learned that these white particles are of extreme importance. For they are what may be called the policemen, or sentinels of the body. They attack any invading germ which might cause illness, and drive it away or take its life. For this reason the white corpuscles are called *phagocytes* or "cell eaters."

If the body is well nourished the white cells are vigorous and numerous, and able to destroy

harmful organisms. If the body is starved or otherwise weakened the white corpuscles are less numerous and less active. The disease-bearing organisms then escape destruction, fasten themselves on the organs of the body, and produce the various contagious and epidemic diseases from which we suffer. Tuberculosis, diphtheria, measles, smallpox, typhoid fever, and pneumonia are types of such diseases. Hence the importance of having the blood sound, healthy, and vigorous.

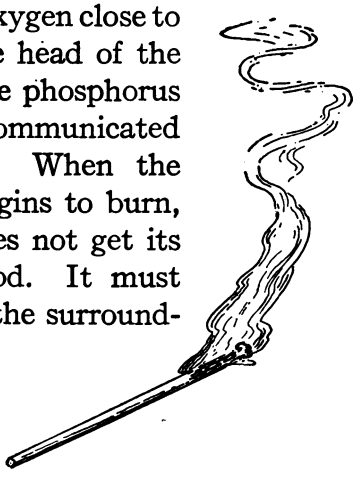
These germ diseases affect the *pulse*, which shares in all the variations of the heart's action, since it is only the beating of an artery. Hence the doctor always studies the pulse.

QUESTIONS TO HELP THE PUPIL

1. What is meant by the "circulation" of the blood? 2. What three groups of blood vessels help the blood to circulate? 3. Describe each group. 4. What are the systemic and pulmonary circulations? 5. Describe the work of the blood. 6. Name the excretory organs and show how they help to complete the work begun by the blood. 7. What are blood corpuscles? 8. What is their use? 9. How does the work of the white corpuscles differ from that of the red corpuscles? 10. How can we assist these little helpers of ours to do good work? 11. If we do not take good care of them what happens? 12. What is the pulse? 13. How does the pulse help the doctor?

IX. A Study of Combustion

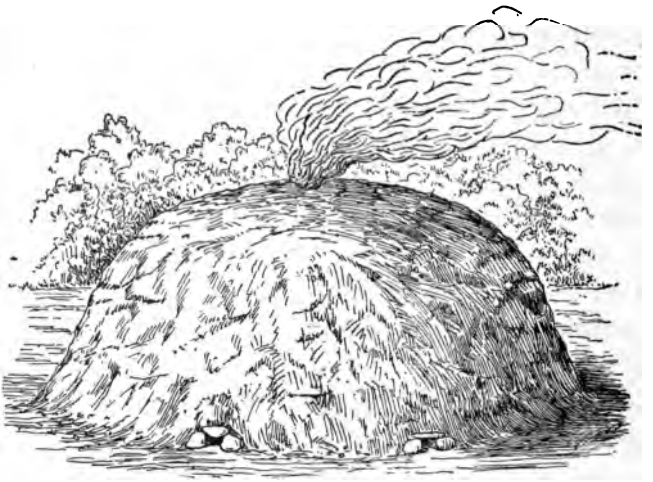
What are the relations of air and fire? There can be no fire, as it is commonly understood, without air. When we strike a match for the purpose of starting a fire, the friction causes enough heat to ignite or light the phosphorus on the match, a substance which takes fire easily. The large quantity of oxygen close to the phosphorus on the head of the match is liberated, the phosphorus burns, and the fire is communicated to the wooden stem. When the wood of the match begins to burn, however, the flame does not get its oxygen from the wood. It must draw its oxygen from the surrounding air. Thus, after the flame is started by friction it continues to burn by taking oxygen from the air. As the little particles of oxygen in the air rush into the flame and unite with the wood, sufficient heat is generated to start a more rapid combustion, and this burning will continue until the flame is extinguished or until all the



A lighted match

combustible matter in the wood has been burned up and only a little carbon remains.

How does coal burn? Coal burns in exactly the same way as wood. But as a rule more heat is required to ignite coal than to ignite wood. The coal fire, therefore, must have more kindling before it ignites, though the principle is exactly the same in both cases. The little

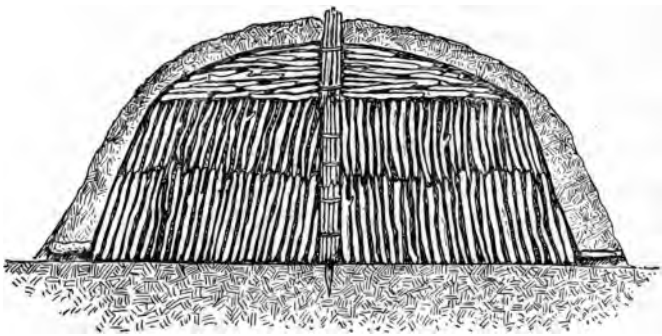


A charcoal furnace

particles of oxygen in the air unite with the coal at a high temperature. This produces additional heat, and thus the combustion is transmitted from particle to particle until all has been consumed. Burning is a chemical process.

What is the element in wood and coal that helps to make the flame and the heat? When wood and

coal are burned, oxygen unites with a substance called carbon. You are familiar with carbon in many of its forms. When your lamp smokes it turns the chimney black with a coating of carbon. Carbon is present in large quantities in coal. It is also present in charcoal, a material produced by burning wood and limiting the amount of oxygen so that the wood will not be entirely consumed. A diamond is pure



Section of a charcoal furnace, showing arrangement of wood for burning

crystallized carbon. So-called "lead" pencils are made of graphite or "writing stone," which is another form of carbon.

What substances are produced when wood and coal are burned? The burning of wood, coal, gas, and oil produces practically the same substances as are created by the burning of foods and tissues in the body. The gases that are formed consist principally of carbon dioxide

and water. The oxygen in the air unites with the carbon and hydrogen in these various materials—wood, coal, food, and body tissues—and carbon dioxide and water are the results of the combustion.

Thus the principal products of combustion, whether in a fireplace, in a stove, in a furnace, in a lamp, in an engine, in an automobile, or in the human body, are carbon dioxide and water. The water is gaseous at the time of its production, because of the high temperature, but when it passes into the air it readily cools and, if the air is nearly saturated with it, fogs and drops of water will form. The carbon dioxide passes into the air just as it does from the lungs, and immediately mixes with the air. The amount of this gas present in open air is not great. The proportion of carbon dioxide in the air is about four parts in ten thousand, and remains almost the same, except in the neighborhood of large cities and factories.

QUESTIONS TO HELP THE PUPIL

1. Can there be fire without air? 2. What gas present in the air is necessary for combustion? 3. What gases are formed by burning? 4. What is the proportion of carbon dioxide in the air?

5. What gases pass out of the lungs in breathing? 6. What then is the process that goes on in the blood and in the tissues of the body?

X. The Temperature of the Body

What is the relation of the heat of the body to health? The temperature or heat of the human body when in a state of health is practically unchanging. It is about ninety-eight and a half degrees. The heat of the body is maintained by the union of the oxygen in the air which enters the body by way of the lungs with combustible matters — the foods and tissues — in the blood and in the capillaries.

Our usual idea of combustion is a burning with a flame or a visible glow. Any process by means of which oxygen combines with organic matter and produces heat is combustion.

A heating stove

We usually think of fire in connection with a stove or a fireplace or a furnace. But the

flameless fires which warm the human body are in the blood and in the minute blood vessels or capillaries of the body.

Although the lungs are the organs which take up oxygen, the combustion which heats the body does not take place in the lungs. The lungs simply provide a means of starting the oxygen

An open fireplace

taken up from the air on its way to the various parts of the body where the burning takes place. The fires that burn in the body have no visible signs of flame or fuel. The lungs produce heat only in proportion to their weight compared to the rest of the body.

How is the heat of the body kept constant and normal? The normal temperature of the body

is about ninety-eight and a half degrees. This is the temperature at which the functions of human life are carried on to best advantage. If the temperature rises above that point we have a fever; if it falls below it we are at the point of collapse. Thus nature must keep the body at a constant, even temperature, and this is accomplished by various means.

In most parts of the world and at almost all hours of the day the body is warmer than the air. Therefore heat is constantly passing from the body to the air. Thus radiation from the surface of the body disposes of part of the excess heat in the body.

Large quantities of heat are also carried out of the body in the air breathed out of the lungs. The air enters the lungs, say at a temperature of sixty-eight degrees. It leaves the lungs at a temperature of about ninety-eight and a half degrees. Thus a large quantity of heat leaves the body by way of the lungs.

The pores of the skin, also, are constantly exuding or discharging water known as perspiration or sweat. This water also carries off a large quantity of heat. As it comes to the surface of the body it evaporates, absorbing a great deal of heat and thus cooling the surface of the body. The drier the atmosphere, the more rapidly the water evaporates. In very

dry climates temperatures of one hundred ten or one hundred fifteen in the shade are endured without much discomfort because the rapid evaporation of the sweat keeps the surface of the body cool. When we work very hard, or the air is very warm or is saturated with the vapor of water, the sweat gathers in drops and often runs off the body like raindrops from the clouds.

Thus the lungs and the skin play almost equal parts in providing for the distribution and sending out into surrounding space of the surplus heat caused by the regular activities of life.

And while nature burns a great deal more material than is necessary to keep the body warm enough, it has so arranged matters that the inner temperature remains practically the same all the time. The activity of all the organs thus remains normal, and health is maintained.

Other factors must also be considered in this connection. The building of houses, the wearing of clothing, and the custom of heating the air in which we live, all tend to maintain an even temperature in the body.

What rule should govern the wearing of clothing? For the purpose of keeping the body warm, clothing should be adapted to the season of the year. Heavier garments should be worn in cold weather, and lighter clothing in warm weather. Clothing, however, should always be as light

as possible, though heavy enough to secure the desired result. Too much clothing is very

Boys wearing heavy and light-weight clothing

injurious, especially to children. Too much clothing hinders the work of grown people, reduces efficiency, and in order to get rid of the excess of temperature throws upon the excretory or expelling organs of the body a larger burden than they ought to bear.

In very cold weather, if you must remain indoors most of the time, it is wise not to wear too heavy underclothing. It is far better to have extra wraps, overcoats, and cloaks to put on when you go out and to lay aside when you again go indoors. In most houses the temperature in winter is kept as high as, and sometimes higher than, in summer. Although the

temperature of the living room should be kept practically at sixty-eight degrees, it is a very common thing to have it much higher, especially in schoolrooms, public halls, and churches, as well as in offices. A great many people spend their winters in rooms heated to above seventy degrees and sometimes as high even as eighty degrees. At the same time they wear heavy winter clothing. Such practices cause serious injury to health.

It is better not to wear heavy underclothing, even in winter. If you go out of doors and are not engaged in active work, overcoats and cloaks and wraps will keep you warm. If you are engaged in active work out of doors, you will not need nearly so much clothing, and as it is usually necessary to go indoors from time to time, heavy clothing is a burden. Thus it is a mistake to wear heavy underclothing in winter. The danger is especially great in the spring, when the heavy clothing is changed for lighter and the weather suddenly becomes cold again. In order to avoid this danger the safest plan is to wear as little clothing as you can to protect you from the cold.

In what other ways may we control the heat of the body? The character of the food we eat is highly important in this connection. This point is treated fully in Book Two of the

Series. It is sufficient now to say that the fats, especially, are the heating foods. A certain quantity of fat produces as much heat, when burned in the body, as two and a quarter times that quantity of sugar or starch, and more than twice as much heat as the same weight of a nitrogenous body, such as lean meat, the white of an egg, or casein of milk. In cold weather, therefore, we should eat more fat and in warm weather less fat. Meats and oils, the foods that contain fat, while splendid foods for winter, should be eaten only in small quantities in summer. The importance of thus controlling the temperature is not fully appreciated by most persons.

What causes a fever? A disordered condition of the body causes a more rapid burning up of materials in the body than a normal state of health. The result is an amount of heat which cannot be controlled or expelled rapidly enough to prevent a rise of temperature, and we have what we call a fever.

The fact that we have a fever always indicates some disordered condition of the body which may or may not be of a serious character. A rise of temperature of even one degree is the signal that the body has passed from a state of health to a state of ill health. It is true that in a state of health the normal temperature may

vary almost as much as one degree during the day, there being daily variations, as well as variations at longer intervals. There is always a slight increase in temperature after violent exercise or after eating a hearty meal, or perhaps as the result of some undue excitement. Such increases, however, are not sufficient to cause disorder in the functions of the organs, and do no harm.

As a rule, nature's first signal that something is wrong is a variation in the heat of the body. On a railway train, when the oil is not properly transmitted to the axle, we have a hot box. In other words, the car axle has a fever.

How high does the temperature rise in case of sickness? In a light fever the temperature of the body is from one to two degrees higher than normal. When the fever is severe the temperature reaches one hundred three or one hundred four degrees, or four and a half to five and a half degrees higher than normal. If the temperature rises above one hundred five degrees it is an indication that the patient is in a very serious condition. In very severe cases of fever, as in typhoid, the temperature sometimes reaches one hundred five and even one hundred six degrees, and yet the patient will recover. Such high temperatures, however, are usually a sign of approaching death.

How may the temperature of the body be measured? The temperature of a sick person is measured by means of an instrument known as a clinical thermometer. The clinical thermometer is a small, carefully constructed thermometer, so adjusted as to register temperatures from ninety to one hundred ten degrees. Generally the bulb of the thermometer is placed under the tongue and the mouth is tightly closed. The clinical thermometer is so delicately adjusted that within one or two minutes after it is placed in the mouth it will register accurately the maximum temperature of the mouth. The column of mercury is also so adjusted that it will remain at the highest point. Thus it may be read at leisure, and an accurate record secured.

Clinical thermometer

What are some of the principal evils of overheating? Overheating, if it is not excessive, does not as a rule produce any great increase of temperature in the body, for the reason that the healthy body is able to eliminate the excessive heat. Overheating and too much clothing are common causes of ill health and suffering. Children and especially infants are injured, for the tendency of careful mothers is to bundle them up with entirely too much clothing. While

it is true that an infant should be carefully protected from the cold in the first days of its life, it is soon strong enough to bear a cool

The way of the modern school girl

atmosphere without a large amount of wraps.

There should be only enough bed clothing to keep a person warm. If his digestive functions are in good condition a healthy person can sleep comfortably in a very low temperature without a large quantity of bed clothing. At certain times in northern climates the temperature falls very low. Then we need more clothing for outdoor use and for the bed.

Mothers should never wrap warm clothing around the necks of their children. The person who wears fur collars, comforters, and

things around the neck catches cold very easily. The health of the child should never be sacrificed to prevailing styles, if these require such things. Children's clothing should be so made as to leave the neck bare. In this way they are much more likely to go through the winter without colds.

The keeping of an even temperature in the body is one of the fundamental conditions of health. If we desire to aid nature we must be careful in regard to our eating, in regard to the temperature of the rooms in which we live and of those in which we work, and in regard to the kind and amount of clothing we wear.

QUESTIONS TO HELP THE PUPIL

1. What is the temperature of the body when in a state of health? 2. How is the heat of the body maintained? 3. What is the difference between combustion in the body and a real fire? 4. How does the body get rid of excess heat? 5. How do the lungs send off the heat? 6. How do the pores of the skin keep the body cool? When are the pores most active? 7. What rule should be observed in the wearing of clothing? 8. What is the effect of too heavy clothing? 9. Does the kind of food we eat influence the heat of the body? 10. What is a heating food? 11. When should we eat less fat? 12. Does the temperature of the body change in sickness? 13. If the temperature rises what do we say the person has? 14. How high may the temperature rise in case of fever? 15. How may the temperature be measured? 16. What is one of the fundamental conditions of health? 17. Of what things must we be careful in order to keep an even temperature in the body?

XI. The Skin and Its Functions

What are the functions of the skin? The skin is the protective covering of the body. It is an important organ of the body. It plays a leading part in the maintenance of an even temperature in the body. It serves to protect the more tender tissues lying under it, and to take care of certain excretions or waste products which are necessary to health and life.

One of the chief functions of the skin is to give us the sense of touch. Innumerable nerves or nervelets connected with the larger nerves and the nerve centers of the body end in the skin. We feel through the skin. The nerves in the skin carry the sensation of touch to the nerve centers and to the brain. We can tell by touch whether things are hard or soft, hot or cold. Thus to a great extent it is through the skin that we become acquainted with the outside world. Blind people, through their sense of touch, read with their fingers.

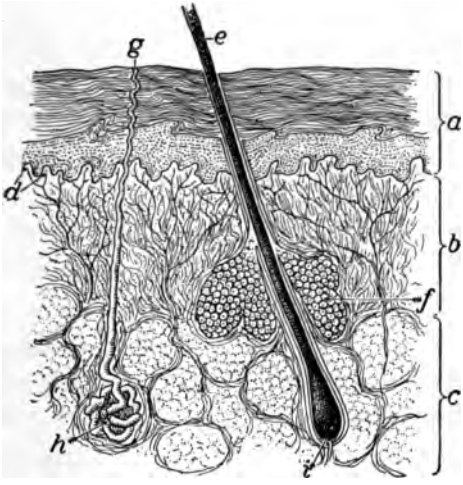
What is the structure of the skin? The outer layer of the skin is called the *cuticle* or *epidermis*. This tough, outer layer is constantly being rubbed off, while materials for a new outer layer form under it. The cuticle carries neither nerve filaments nor blood vessels; hence it may

be removed without pain and without causing any blood to flow.

If any part of the cuticle is rubbed continually, it grows more rapidly and becomes hard and thick. If you examine the hands of a man who does rough work, you will find the skin comparatively hard, tough, and thick. The cuticle on the sole of the foot is much thicker and harder than it is on the top of the foot. When boys go barefoot the cuticle on the soles of their feet thickens and hardens. If a person wears tight or ill-fitting shoes that rub on the skin over a joint, the cuticle becomes thickened and hardened and the result is what is called a corn. This hardening of the skin is nature's effort to give added protection to the parts that are being rubbed.

Underneath the cuticle is the *cutis vera* or true skin. On the surface of the true skin are spread the little projections which hold the terminals of the *sensory* nerves or the nerves by which one feels. Here also are the sweat glands, the roots of the hair, and the oil or fat glands. In addition to the protection which the skin provides as a covering for the body, other means of protection are provided by nature—for instance, the hair, and the nails on the fingers and toes. The nails and the hair are really skin tissues with special modifications according

to the needs of the body. There is no better protection for the head from the heat of the sun and the cold of the winter than a thick covering of hair.



The structure of the skin

a, epidermis; *b*, cutis vera; *c*, fatty tissue; *d*, papillae; *e*, hair; *f*, oil glands; *g*, duct of sweat gland; *h*, sweat gland; *i*, papilla of hair

The skin of the whole body is covered with hairs. They are usually very small, but they can easily be seen either with the naked eye or by means of a magnifying glass. Each hair grows up through the skin much as a seed grows up through the soil. The hair does not conduct heat or cold, and therefore a covering of hair or fur is one of the best protections against changes of temperature. Animals that live in cold climates have heavy fur. This fur is a protection against both the heat of the sun in summer and the cold of winter.

How does the skin perform the function of regulating temperature? We have already learned

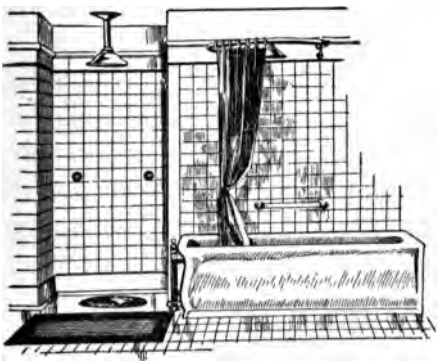
that the heat of the body is influenced not only by the thick covering the skin provides but also by the sweat glands in the skin. The sweat glands eject certain watery secretions from the body. But sweat is not pure water. Sweat contains other substances in solution, among them considerable quantities of common salt. Sweat glands are present in all parts of the true skin, though not in the cuticle. They are usually surrounded by particles of fat. This fat keeps the sweat glands pliable and assists them in their important work. Each one of these glands has a very small duct or tube which leads spirally, that is in a winding way, through the true skin and the cuticle. The opening is not even with the surface of the skin, but is oblique, in order to be more easily kept from becoming clogged by substances clinging to the surface of the cuticle. These ducts are larger and more numerous in the skin in those parts of the body that are most active in sweating, as, for instance, in the skin of the forehead and the arm pits. It is estimated that on the palm of the hand there are about three thousand of these openings to each square inch of surface.

We have already learned that one of the two principal products of combustion in the body is water, the other being carbon dioxide. Much

of this water is excreted or thrown off through the sweat glands, while the carbon dioxide is almost entirely excreted through the lungs.

Is cleanliness of importance to health? The skin may be regarded as a machine. As in the case of other machines, its efficiency may be maintained only by close attention and care. If a watch is to be kept running accurately it must be taken apart from time to time and thoroughly cleaned. The watch, in other words, must have a bath.

The surface of the skin is constantly exposed to disease or infection from its own excretions, and from those substances which may be deposited on it from the atmosphere and from the objects with which it comes in contact. Hence frequent cleansing of the skin is necessary. Careful boys and girls will wash their hands several times a day and their fa[illegible] at least once. Although most of the b[illegible] is protected by clothing from the han[illegible]



A corner in an up-to-date bathroom

substances in the air, it is much more likely to be harmed by excretions of the body than are the hands and the face. Hence the whole body needs to be bathed frequently and thoroughly. Whenever conditions allow—and conditions are rarely ever so unfavorable as to prevent—the bath should be taken daily. The bath is most refreshing and of greatest benefit if followed by vigorous rubbing and kneading of the body.

A swimming pool

What should be the temperature of the bath? As a rule the temperature of the bath should be as nearly as possible the same as that of the living room. About sixty-eight degrees is the ideal temperature for the morning bath. It may safely be a little lower or a little higher, according to the different seasons. A hot bath with soap is to be preferred for cleansing purposes to the cool bath with pure water. A cool bath with pure water and a little soap, however, if taken daily, will keep the body clean, even if the temperature of the water is

no higher than seventy degrees. For young children and infants the temperature of the bath should be about the same as that of the body. Very young infants should be bathed in water not under ninety degrees in temperature; children of from one to two years in water not under eighty degrees. For children over three or four years of age, the standard temperature of sixty-eight or seventy degrees is best.

Since the skin is a very important organ in regulating the temperature of the body and keeping it at the normal, and has many other important functions, it should be given the greatest care that it may remain healthy and in the best condition.

QUESTIONS TO HELP THE PUPIL

1. Why is frequent cleansing of the skin desirable? 2. What makes the bath most refreshing and beneficial? 3. What is the best temperature for the bath for children from one to two years old? over three or four years? 4. What are the chief functions of the skin? 5. What is the outer layer of skin called? 6. What happens to the epidermis when it is rubbed continually? 7. What is the name given to the true skin? 8. What organs are located in the *cutis vera?* 9. What modified forms of skin tissue are provided for the body's protection? 10. Why is hair a protection against changes of temperature? 11. What is the function of the sweat glands? 12. What is the purpose of the fat or oil surrounding them? 13. Why are the openings of the sweat glands placed obliquely? 14. About how many sweat glands are there to a square inch on the palm of the hand? 15. What product of combustion is thrown off through the sweat gland

XII. Water and Its Function in Health

What is water? We have seen how the oxygen of the air unites with the hydrogen and carbon of the foods and of the tissues and produces water and carbon dioxide. Attention has also been called to the fact that if we place a piece of wood or coal on the fire, and it burns, much the same kind of "smoke" is produced as that which arises in the human body. In other words, the greater part of the "smoke" that goes up the chimney or comes out of the lungs is composed of carbon dioxide and water. When carbon dioxide and water are in the form of gas they are not visible. In the smoke that goes up the chimney the carbon dioxide and water are not visible; the smoke we see consists chiefly of such impurities as unburned carbon. Neither do we see the "smoke" that comes out of the lungs unless the air into which it is breathed is cold. The cold condenses the moisture and it then becomes visible. This also happens if we breathe on a cold polished surface, like glass or metal.

What is the chemical composition of water? Water is composed of two substances, known as hydrogen and oxygen. We have learned that oxygen is an important part of the mixture we

call air. But hydrogen is not present in the atmosphere under ordinary conditions.

Thus the air we breathe into our lungs may be said to contain no hydrogen except that in the watery vapor which is always present in the air.

What are some of the chief properties of water? We are so familiar with water that we scarcely ever think of trying to describe it. Water produces the condition we call *wet.* We are perfectly familiar with that condition. If we stand out in a rainstorm a little while our clothes are wet through and through.

Water also has the power of dissolving substances. If you put a piece of sugar in water it begins to dissolve rapidly. If you stir the water it will dissolve more rapidly. If you place the lump of sugar in a spoon and hold it just below the surface of the water it dissolves as rapidly as if the water had been stirred. If you make this experiment in a glass vessel, and hold it up to the light, you will see the melted sugar flowing down in currents through the water, although it is perfectly colorless. The sugar solution flows to the bottom because it is heavier than the water. It thus makes room at the top for the water that has less sugar in it, and the solution of the lump of sugar goes on with greater rapidity. If you put a

of salt in the water the same thing will occur, but more slowly. Thus we say that sugar is more soluble in water than salt.

Does the temperature of water affect its power to dissolve substances? Yes, very markedly. As a rule hot water dissolves a greater amount of a substance than cold water, and does it more rapidly. In the case of common salt, however, the reverse is true. Cold water will dissolve salt more rapidly and in greater quantity than hot water.

Water dissolves almost everything with which it comes in contact. Thus the water that runs down through the rocks underground and flows out again in a spring will carry in solution traces of the rocks with which it has come in contact. If iron ores are present in the rocks the water will carry away traces of iron. If there is marble or limestone in the path of the water through the earth it will dissolve large quantities of these substances. And so with almost every other known substance. But there are a few substances that are extremely insoluble in water—for instance, metals such as gold, silver, and platinum, though under certain favorable conditions even tiny bits of these substances may be found in water which [illegible] through rocks. Water has been very [illegible]alled the "universal solvent."

What effect has heat on the volume of water? Heat affects water, as it does most other substances, by increasing the volume or amount. To prove this, fill a vessel with cold water and in the mouth of the vessel place a cork with a glass tube through it. Then set the vessel over the fire, and you will see the liquid mount rapidly in the tube. The water is expanded by the heat and is forced into the tube. The expansion continues until the water begins to boil.

How much water is there in the human body? The human body is practically three fourths water. The food we eat contains about the same relative amount of water as does the human body, that is, seventy-five per cent. Some foods contain a great deal more water. Milk, for instance, contains eighty-seven per cent. The cereals, on the other hand, when uncooked, contain only about twelve per cent. Refined sugar contains practically no water. But as a whole the proportion of water in our food is about seventy-five per cent.

How much water should we drink? This is determined largely by the feeling of thirst or desire for water. Thirst is nature's best way of telling us, through the nerves, that the body is demanding a larger supply of water. Thirst may be produced in many ways. If we eat a great deal

of salt or sugar, both of which require a considerable quantity of water to dissolve them, more or less water is drawn from the tissues with which these articles come in contact. This taking away of the water, usually from that in the stomach, produces a sense of thirst, which we gratify by drinking water.

The sense of thirst is also usual in hot weather, because so much water is discharged from the body in the form of perspiration. If we play or work hard on a hot day we speedily become thirsty, for the quantity of water in the body is distinctly reduced by perspiration. A very slight decrease in the quantity of water in the tissues will produce a sense of thirst.

Those who drink alcoholic beverages in considerable quantities also become thirsty. This is nature's way of telling us that these poisonous liquids should be diluted or weakened as much as possible. Like salt and sugar, alcohol also extracts or draws water from the tissues with which it comes in contact.

There are many other things that cause thirst. Dry foods or overeating, especially of meats and highly seasoned foods, is a cause of thirst. A fever, or a bodily temperature higher than the normal, usually makes us thirsty.

Thus we see that thirst may be a normal condition, caused by physical exertion, hot

weather, or eating dry foods. It may also be an abnormal or unusual condition, as when it is caused by taking large quantities of salt, sugar, candy, meats, highly seasoned foods, and alcoholic beverages, or when a person is ill with a fever. But whether the thirst is normal or abnormal the best plan is to drink water.

Is there any other method of quenching thirst besides drinking water? All kinds of beverages are used for the purpose of quenching thirst. Among them are the so-called "soft drinks." These drinks are made principally of sugar, caramel or burnt sugar, some aromatic or a bitter principle like extract of bitter almond, and water. They are usually very sweet, and are poor beverages for quenching thirst. Drinks to which substances such as caffeine, found in coffee, or

At the soda water fountain

cocaine, found in the coca leaf, have been added are also supposed to quench thirst. Coca Cola is a type of soft drink containing caffeine. Moreover the drinks containing alkaloids are harmful. Tea and coffee are said to quench thirst. Lemonade and orangeade and soda water are sold in large quantities to satisfy thirst. But none of these so well answers the purpose as pure water of the right temperature.

What should be the temperature of drinking water? Unfortunately, it is the custom in the United States to use drinking water that has been reduced almost to the temperature of melting ice. It is common, especially in summer, to place ice in the drinking water. This is a harmful practice. Drinking water should be kept at a temperature not lower than fifty degrees and not higher than the temperature of the body. At those temperatures it is extremely palatable and not at all injurious.

Ice-cold beverages should be avoided, especially during the hot days of summer, the season of the year when such drinks seem most agreeable. It is harmful to fill the stomach with ice-cold water when one is very warm.

"Full many a man, both young and old,
Has gone to his sarcophagus
By pouring water icy cold
Adown his hot esophagus."

What is meant by pure drinking water? By "pure drinking water" we do not mean a liquid that consists of nothing but absolutely pure water. Pure waters are extremely difficult to obtain. The purest are those produced by the condensation of steam from boiling water. But even such water may contain gases, which are carried with the steam. Moreover, the water may boil so violently as to send particles of other substances into the steam and so into the condensed water. Absolutely pure water can be obtained only by the most carefully controlled chemical operations. Distilled water on sale in drug stores is reasonably pure. The rain water which comes after it has rained a long while is almost pure, but not entirely so.

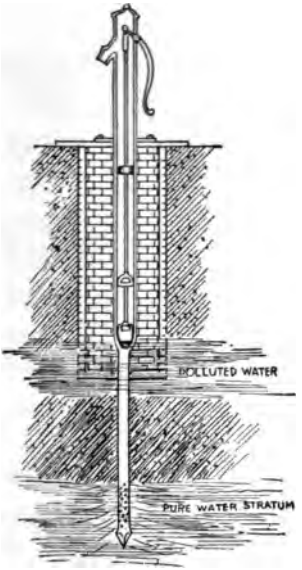


Diagram of a well

Pure drinking water really means water that is free from any dangerous infection and contains only a reasonable quantity of dissolved matters. The purest natural waters are those which come from deep springs or wells situated in localities

where the rocks are highly insoluble and which are far removed from manufacturing industries and human habitations. The waters in springs found on uninhabited mountains may be regarded as types of the purest drinking waters. Water coming from great depths, as in Artesian wells, is often reasonably pure so far as freedom from organic infection is concerned, but it is often highly charged with dissolved mineral substances.

Diagram of a spring

Absolutely pure water, even if it could be obtained in sufficient quantities, would not be the best for drinking. The dissolved mineral substances which are contained in spring and well water are favorable to health. Especially is this true of the lime, magnesia, and iron which such waters usually contain.

Are we well supplied with well or spring water? No, the greater number of people in the United States live in towns and cities. The water supply for the towns and cities is often taken from a near-by lake or river. Waters from such

sources are nearly always impure or polluted. They carry, in addition to harmless mineral substances, large quantities of organic matter derived largely from manufacturing industries and from human habitations. Many such waters are not pure and are extremely dangerous for drinking.

How are these waters made suitable for use? In some places the waters are used for drinking without any purifying treatment. In such localities typhoid fever and other disease germs are sometimes found in the water.

The two principal methods of purifying the water of running streams and rivers to make it suitable for drinking are filtration and purification by chemicals. These two methods are often combined. The water is first treated with chemicals to start the purification, and is afterwards filtered. The filtering medium is usually sand. When infected or dirty water passes through the filter bed it deposits among the sand particles the *silt*, or fine mud, which it carries, so that the muddy or infected water comes out of the sand filter reasonably pure.

Nearly all our large cities which get their water from running streams use some kind of a filtering apparatus. In many places the waters are first treated with chemicals to destroy the organisms that are injurious to health. Lime,

chlorinated lime, sulphate of iron, and alum are the principal elements used for purifying water.

How does such treatment of water safeguard health? Water purified for drinking purposes is practically free from disease-producing germs. Therefore such diseases as typhoid fever, cholera, and dysentery, which may be transmitted through water, are prevented if the water is purified. Severe epidemics of typhoid fever have been caused by a polluted or impure water supply.

Polluted water in streams and rivers also injures the fish, oysters, and crabs that live there. Shad at one time entered the Hudson River in as great numbers as they do the Potomac. But the sewage of New York has polluted the waters of the lower Hudson and now few shad pass through to the purer water above. When these unclean waters are carried to oyster beds, the oysters themselves may become infected. Numerous cases of typhoid fever have been traced to the eating of oysters that have been taken from waters made impure by city sewage. All this shows the immense importance of a pure water supply to a city. In all cases where perfect protection is secured the drinking water is boiled.

How much water should [illegible] **at our meals?** It has often been said by [illegible] alth that

it is not desirable to drink while eating, because the use of a beverage while chewing tends to restrict the flow of saliva. Hence, since it is a necessity to mix enough saliva with the food to start the process of digestion, to drink a great deal while eating is injurious.

We should also learn to chew our food well. As a rule we swallow it too soon after we put it into our mouths, and the use of a beverage during mealtime encourages this habit. This is another reason why we should take very little liquid while we are eating.

Recent investigations have shown that to drink moderate quantities of water with our food does not seem to prove injurious, and may even promote digestion. When studying the process of digestion we find that it depends upon the action on the food of certain ferments. If the mass of food is too dry these ferments have difficulty in reaching it. If there is too much liquid, they become less active.

If a person eats a very starchy food he should not drink water while eating, but he may do so immediately afterwards if he feels the need of it. Starchy foods are digested largely by the saliva and hence should be chewed as long as possible, so that the salivary glands—the glands that produce the moisture of the mouth—may act as vigorously as possible. In eating meat,

the saliva is not important, and liquids may be used with less harm than when one is eating foods such as potatoes and bread.

In all cases, the drinking at meals of large quantities of liquids other than water, unless it be milk, is not advisable. It is better to wait until after the meal. Then we may drink water without injury to the digestive process.

It is certain, however, that articles of food, except juicy vegetables, do not contain enough water for the needs of the human body, and it is therefore desirable to drink additional water. The amount required varies greatly with the tastes and habits of the individual and the character of his food. If we eat juicy foods, such as turnips, lettuce, celery, asparagus, green peas, green beans, or green corn, we need very little additional water. If, on the other hand, we eat bread, meat, sugars, and oils, we need a great deal more water.

An abundance of water at the right time has a favorable effect on the digestion. It keeps the contents of the intestines from becoming too hard, and thus aids in preventing constipation. A good practice is to drink a tumbler full of good water at a temperature of sixty to sixty-five degrees immediately on rising each morning and to take the same amount before going to bed at night.

In general, the degree of thirst determines the quantity of water that should be drunk. You are not likely to injure your health by drinking too much water, if it is pure and of the proper temperature.

What happens if you drink more than thirst requires? Usually a little more water than is normally required to satisfy thirst will not prove harmful. The healthy body keeps the proper balance of water in the blood. If a little too much water is taken, it is eliminated without much trouble through the kidneys, through the skin, and in other ways. But in diseased conditions of the body, as in a hardening of the arteries or in diseases of the heart, an excess of water may prove harmful. The excretory organs are then unable to do their full duty, thus increasing the volume of the blood and throwing an additional burden on the heart and the imperfect arteries. These diseases do not usually attack children or young people, but are common in later life. People past forty or fifty years of age, whose blood pressure is above the normal, should limit the quantity of liquids in their foods to the smallest amount necessary for proper digestion. This is a matter to be decided by the physician and not by the schoolbook.

Is water used as a medicine? The use of water

in keeping clean is to a certain extent medicinal. Washing the hands is distinctly an attack upon disease, for clean hands are less liable than dirty hands to carry disease to the mouth or to impart disease to others. The common habit of washing the hands and face in the morning is to be commended from a point of view both of cleanliness and of health. It is well to repeat this operation at noonday and at night.

The bathing of the whole body is likewise a health measure. Water and a little soap, the rubbing which one receives in bathing, and the drying with a coarse towel, tend to promote the healthy action of the skin. These things all help to supply the body with the proper amount of blood, and to keep the pores open and in condition to perform their normal functions. For the same reason massage—the kneading and pounding of the body—is also conducive to good health. The use of water, therefore, is one of the most valuable methods of preventing disease, for through water we secure cleanliness.

Is water ever used in sickness? Water is constantly used as a remedy by physicians. Because of its great power of absorbing heat it is used very generally in cases of fever, either in the liquid state or frozen. Bathing the body

of a person suffering from fever cools the surface of the body and is refreshing to the patient. Copious drafts of water, usually warm water, are used internally to produce vomiting. If a little salt is added to the water, it acts more promptly. For this purpose the water should be lukewarm, neither very hot nor very cold.

What is meant by "taking the waters"? Those persons who go to drink the waters from mineral springs which are reputed to be of value in certain diseases are said to be "taking the waters." When people go to the springs they are placed on a rigid diet, usually very simple, consisting of a little fruit and hard bread, the water of the spring being their only beverage. The waters at such springs are usually known as mineral waters; that is, they contain more of the materials derived from rocks than ordinary spring or well water. These materials or mineral substances have a medicinal action. The water contains more or less lime, an excellent remedy for many diseases. The benefit which people secure at the springs is probably due as much to the rigid diet on which they are required to live as it is to the use of the mineral waters themselves.

Could life be continued without water? Water is as necessary to a living being as air or food. If you were deprived of water you would die as

quickly as if you were deprived of food, or even more quickly.

If you have plenty of food, even though it is dry, a good deal of water will be generated when the food is eaten, because all the hydrogen which the food contains will be burned into water in the body. But even that quantity of water is insufficient to support life for more than a short time. The average amount of water in the ordinary foods we eat is about seventy-five per cent, but even with so much water we are required constantly to take additional quantities. You can readily imagine what would happen if all our foods were entirely dry and we had no access to water. We should live only a few days.

Long ago the Latins had a motto which, when translated, reads: "Bodies do not act unless they are in solution." Water, as has already been said, is the universal solvent. All the foods we eat must pass into solution in water before they can be taken up into the blood.

QUESTIONS TO HELP THE PUPIL

1. Can we see carbon dioxide and water when they are in the form of gas? 2. What substance do we see in the smoke that goes up the chimney? 3. What happens to the water in the breath when the air is cold? 4. Of what substances is water composed? 5. What happens when you put sugar in water? 6. Does hot water dissolve substances more rapidly than cold water? 7. What

substance is an exception to this rule? 8. What is a mineral water? 9. Why is water called the "universal solvent"? 10. Tell what happens when water is heated. 11. What proportion of the human body is water? 12. What proportion of water do most foods contain? 13. Name some foods that contain less than this proportion. Some that contain more. 14. Why are we thirsty in hot weather? 15. Why do persons who drink alcoholic beverages become thirsty? 16. What are three natural reasons for becoming thirsty? 17. What are soft drinks? 18. What injurious substances do some soft drinks contain? 19. What is best for us to drink? 20. Should we drink very cold water? 21. What is the best temperature for our drinking water? 22. What is "pure drinking water"? 23. Are the dissolved mineral substances found in spring water good for us? 24. What is the best location for a well? 25. From what sources do most cities and towns get their drinking water? What is the danger? 26. How may water be purified for use as drinking water? 27. What diseases may be transmitted through polluted water? 28. How may polluted water cause sickness indirectly? 29. Should we drink much while eating? 30. What bad habit in eating is encouraged by drinking while eating? 31. Is it best to drink after a meal? 32. What foods require saliva for their proper digestion? 33. What is a good practice in drinking? 34. Why is too much water injurious? 35. How may the use of water prevent sickness? 36. To what uses is water put in sickness? 37. What is meant by "taking the waters"? 38. What minerals do spring waters chiefly contain? 39. Is the rigid simple diet of as much benefit as the waters themselves? 40. Could we live without water? 41. Through what process must all foods pass before they can be taken up into the blood?

XIII. A Study of Microbes

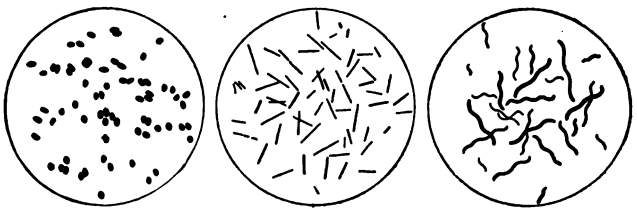
What are microbes (microörganisms)? Microorganisms are living things, either animals or plants, that are so small they cannot be seen without a microscope. The term "microbe" means a small living speck. The term "microorganism" means the same thing. Therefore microbes and microörganisms are interchangeable terms.

Microbes are frequently composed of single cells; that is, they have no organs, as more highly developed beings have. The whole microörganism is but a tiny bit of jelly-like substance called *protoplasm*. Each living cell has a delicate sac-wall inclosing the protoplasm and generally, but not always, a minute, roundish, transparent body within the cell, called the *nucleus*. All organisms of a higher order are made up of masses of cells. Our own bodies are so made up. The cells are of various kinds muscle cells, nerve cells, bone cells, and so on all bound together in the solid parts of the body by fine, transparent connective tissue.

How many kinds of microbes are there? There are two principal classes of microbes, those that resemble vegetables in their life processes and those that are like animals. The microbes

that are of vegetable nature are called *bacteria*. The microbes that are of animal nature are called *protozoa* ("first forms of life").

What are bacteria? The term "bacteria" is applied to a class of vegetable microörganisms which are extremely abundant and widely scattered about, both outside and inside all living things. The bacteria are both useful and harmful. They are usually divided into three classes to which distinctive names are given. They are: *coccus*, a bacterium approaching a sphere in shape — in other words, a minute round globule; *bacillus*, which is a bacterium in the form of a slender stick or rod; and *spirillum*, a bacterium which has a twisted shape like a corkscrew. These differently shaped organisms merge into each other by a process so



Three classes of bacteria
A, micrococci; *B*, bacilli; *C*, spirilla

gradual that it is difficult at times to tell where one ends and the other begins. There

many general species and varieties of these organisms, numbering hundreds in all.

- **Microörganisms** (Microbes)
  - *Bacteria* Live in air, water, food, and in living bodies
    - Cocci (like a little seed, rounded) { Good / Bad
    - Bacilli (pencil-shaped) { Good / Bad
    - Spirilla (like a corkscrew, twisted) { Good / Bad
  - *Protozoa* Live mostly in water
    - Rhizopods
    - Sporozoa
    - Infusoria

What are some of the useful bacteria? Useful bacteria are those which perform useful operations. All bacteria tend to destroy or break up organic matter. The soil, for instance, contains considerable quantities of materials resembling protein. Decaying animal and vegetable matter furnish a large part of this material. As long as it is protein and undecayed or undecomposed it is not suitable food for new plants; in other words, it is not useful as a manure. These substances must be broken up into simpler bodies before they can be used as plant food. There is a so-called nitrifying bacterium which eats protein matter and produces nitric acid. The nitric acid combines with bases in the soil

and forms nitrates (nitrate of lime, nitrate of potash, etc.).

A certain kind of nitrifying organism lives on the roots of some plants called legumes, such as clover, peas, beans, alfalfa, and other plants of this kind. There they form little nodules (rounded bodies), which constitute the houses in which they live. You can see them on the roots of alfalfa and beans. They act upon the free nitrogen of the air and oxidize it, thus converting it into nitric acid. This is the cheapest source of nitric acid (a very valuable plant food) for the farmer. It is well known that where clover has been grown big crops follow. This is due to the fact that in the clover roots there remain large quantities of protein formed from the nitric acid made by the bacteria, which become available for succeeding crops.

Nodules on root of soy bean

Cream is ripened and made ready for churning into butter by germs called lactic acid bacteria. There are many kinds of bacteria that can make cream sour, but not all of

produce the taste and odor that make good butter so delicious. In sour milk, which is universally regarded as a wholesome beverage, either the sugar of the milk is converted into lactic acid by some added organism, like the Bulgarian bacillus, or it is changed into sour milk by the natural organisms which it contains or which it acquires on standing. Lactic acid also curdles the milk.

Most persons think of germs as being harmful. The term "germ" is another name for a micro-organism or bacterium. It is true that many germs are harmful, but the great majority are perfectly harmless and most of them are useful.

What are the microbes or germs that cause disease? There are many germs of this kind, both animal and vegetable. Some of these organisms belong to the spherical group. For instance, those organisms which cause pneumonia are called *pneumococci*. Many diseases are caused by germs, among them being tuberculosis, sore throat, diphtheria, measles, smallpox, whooping cough, malaria, and typhoid fever. By reason of this fact we naturally look upon organisms that are called germs with suspicion and often with fear. We must learn to discriminate between the good and bad microörganisms. Unfortunately we cannot always kill the bad organisms without killing

also many of the good ones. In general, however, nature has so wisely ordered things as to make the disease-producing germ more easily killed than the harmless or useful germ. This is the principle which underlies the Pasteurization of milk. A temperature of 145° continued for half an hour will destroy the germs in milk that produce tuberculosis, scarlet fever, diphtheria, and other similar diseases. It will not, however, always kill all the organisms that produce lactic acid, though it does kill many of them. For this reason milk which has been Pasteurized will keep sweet longer than milk which has not.

How do bacteria live? In order to live, grow, and multiply, bacteria must have food just like the cells of other plants and animals. Bacteria, therefore, may also be classified according to the kind of food they require. Some bacteria feed on dead animal or vegetable matter. They are very useful to human beings since they cause dead matter to decompose and so put it out of the way.

Bacteria cause decomposition in dead animal and vegetable matter. They break up these substances into minerals and gases. This process is a kind of fermentation. The power of certain bacteria to cause fermentation is of benefit to mankind in some ways. W-

know how bread dough is made to rise by putting yeast in it. Yeast cakes contain organisms (yeast cells) that cause fermentation, forming a gas (carbon dioxide) that makes the bread dough porous (full of holes). Milk is made sour by a certain fermenting bacterium present in the milk. Still others aid in making butter and cheese. So we see that though certain kinds of bacteria cause harm, many are of great importance and value.

Yeasts are also used in making beer, root beer, and distilled liquors.

Another great class of bacteria live and multiply best in the tissues of living things, feeding on the living cells that form the animal or plant structure. Among these are the enemies of mankind against which we try to guard ourselves.

What are protozoa? Protozoa are single animal cells. Though the greater number of protozoa are harmless, certain of these minute animal cells cause some of the most dangerous diseases of mankind. Malaria, possibly yellow fever, and the sleeping sickness of the Orient are among the diseases caused by protozoa. Amoebae (very simple animals) cause persistent diarrhea and are present often in pyorrhea (disease about the roots of the teeth).

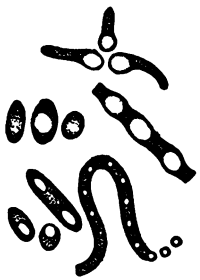
What diseases of the intestines do bacteria cause? Typhoid fever, dysentery, cholera infantum, and

diarrhea are among the diseases of the intestines caused by bacteria. The bacteria are generally of the bacillus, or rod-shaped, form. In some cases of diarrhea, bacteria of the micrococcus, or spherical form, are found. The contents of the intestines are filled with bacteria of many kinds. Some of them produce poisons which may bring on auto-intoxication (self-poisoning), and are claimed by some to cause hardening of the arteries and premature old age.

How do bacteria multiply? When bacteria find the proper food and temperature they grow and multiply. Each bacterium divides into two parts, each part forming a new bacterium which again divides. This process goes on so rapidly that a single bacterium may multiply into a very large number of bacteria in a single day. Fortunately for us, the bacteria and protozoa that cause disease are not always such vigorous growers as many of the better kind. They also have very bitter enemies (phagocytes) in the body (page 87) which attack and destroy them.

Can disease germs live outside the bodies of living things? Germs that cause disease in the human body can exist outside the tissues of the body. Scientists, in order to study the habits of these tiny organisms, have watched them grow and multiply in preparations containing the food best suited to germ growth.

Each germ cell, as we have learned, is filled with a liquid. In this substance may be a minute seedlike grain called a *spore.* Some disease germs are so constructed that they can live for a long time outside the body, or even without food. These depend on their power to form a spore within the cell. The spore begins as a small grain in the rod, and gradually enlarges, and in doing so absorbs all the substance of the rod, until finally the spore is larger than the diameter of the rod. It is inclosed in a strong, firm shell or covering which will withstand an amount of drying and heat that would kill the bacterial cell. In this condition it can remain for a long time, only awaiting its opportunity to develop when it is brought in contact with conditions that are favorable for its growth. Thus one of the greatest dangers of dust-filled air is that such air may contain the spores of disease germs. When the spore has found its way back into living tissues, it changes to a germ cell like that from which it came. Some kinds of germs, however, do not contain spores, and when they leave the bodies of living things they soon die.



Germ cells with spores

A STUDY OF GERM DISEASES

What diseases of the respiratory organs are caused by bacteria? Among the diseases of the lungs and air passages caused by bacteria are pneumonia, tuberculosis, bronchitis, whooping cough, tonsilitis, diphtheria, influenza, and colds. In breathing, eating, and drinking, disease germs may be taken in. In fact, the mouth and throat are always swarming with bacteria, ready to attack the body the moment it weakens in its power to resist them. Sometimes a person, though not ill himself, will carry germs about, and impart them to others who do become ill. Such a person is a "*disease carrier*" and he should be quarantined. (See page 158.)

What diseases of the blood are caused by germs? Among the germ diseases of the blood are malaria and sleeping sickness. These diseases are not caused by bacteria, the tiny plant cells of which we have read. They are caused by a certain kind of protozoa, the minute animal cells. These germs get into the blood from the bites of mosquitoes or flies (pages 58–59). The mosquito called *Anopheles* carries the germs of malaria. The mosquito called the *Stegomyia* carries the germ of yellow fever, the exact nature of which is not known. The germs of malaria attack the red corpuscles of the blood, using them for food. As the protozoa grow

and multiply they consume millions of red corpuscles. They also produce in the blood what is called a *toxin* or a poison that affects the whole body.

What are toxins? Toxins are poisons formed in the body by disease germs. All disease germs produce poisons, some of which are far more deadly than others. Just how the germs bring about the formation of poisons or toxins is not clearly understood, but it is by a kind of fermentation. In most germ diseases it is especially the effect of the toxins produced that is to be feared.

How does the body protect itself against toxins? We have read (pages 87–88) how the white corpuscles attack the disease germs and kill them. But these white corpuscle policemen cannot guard the body against the poisonous toxins after they have been produced by the germs. So nature has provided the body with another safeguard. When germs find their way into the body and begin to produce toxins, a substance called *antitoxin* ("against toxin") is formed in the blood. Just how the antitoxin is produced has not yet been made entirely clear. But it is known that it is a substance with power to neutralize toxins.

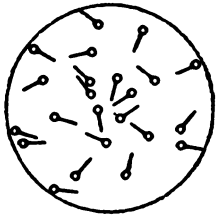
We must not think that there is just one kind of toxin and one kind of antitoxin. The germs

of diphtheria form a very poisonous toxin. In order to destroy this, the body must produce a certain kind of antitoxin called diphtheria antitoxin. This substance has no effect on the toxins of other disease germs. In the same way the antitoxin of the disease called *tetanus* or lockjaw has no effect on the toxins formed in other germ diseases. Diphtheria is far more frequent than tetanus. The doctor should inject the proper antitoxin promptly. This remedy has greatly diminished the death rate from this very dangerous disease.

What is tetanus? Tetanus is a disease caused by a rod-shaped bacterium that has its home in the soil. The tetanus bacilli seem to live especially well in dead animal and vegetable matter. They attack human beings and animals through wounds. They grow best in deep, narrow wounds like those made by a nail driven through the skin. These wounds generally close quickly, shutting out light and air. Such conditions are most favorable for the growth of the tetanus germs. It is very dangerous to run a nail into the foot. One should always go to a doctor and have such a wound opened up freely and sterilized.

The wounds caused by explosives which drive dust and bacteria deep into the flesh are a common cause of tetanus poisoning. As in the case

of other germ diseases, the effect of the germs themselves is not so dangerous as are the toxins which the germs form. The toxin formed by the tetanus germ is one of the most powerful poisons known. Tetanus is called lockjaw because the first effect of the toxin is to stiffen the muscles of the jaw and neck so that the patient finds it difficult to open his mouth. The head is also usually drawn back. An antitoxin forms in the body but in most cases not soon enough to destroy the powerful tetanus toxin. Lockjaw is usually fatal unless vigorously treated with anti-tetanus serum at the very beginning.



Tetanus germs

How can we help the white blood cells? We have seen (page 88) how we can aid the white corpuscles in their work of destroying germs by keeping the body strong and well nourished with good food and air. This also helps the body in its power to form antitoxins. But there are many diseases in which the body cannot produce antitoxins fast enough or powerful enough to destroy the toxins of the invading germs.

Scientists have discovered that the body can be aided in its fight against certain disease germs by supplying it with a prepared antitoxin. To

secure a diphtheria antitoxin, diphtheria germs are kept in a preparation containing food favorable for their growth and development. As they grow they form a toxin just as if they were growing in the body. A little of this toxin is then injected into the blood of a horse. Soon thereafter a diphtheria antitoxin forms in the blood of the horse, for nature has provided the lower animals, as well as man, with safeguards against disease. In order to get as powerful an antitoxin as possible, the diphtheria toxin is injected many times into the horse's blood. A little of the blood is then drawn and used to prepare a diphtheria antitoxin serum. When injected into the blood of human beings this will destroy the toxin formed by diphtheria germs, and just in the same manner as is done when one recovers from diphtheria naturally. By a similar process, a tetanus antitoxin is secured with the aid of tetanus germs.

Injecting toxin into a horse

The use of antitoxins in diphtheria and tetanus has saved thousands of lives. To be effective,

however, these counter-poisons should be taken in the early stages of the disease. This is especially true of tetanus, whose toxin is formed quickly and is very powerful.

What is vaccination? We have learned that the bodies of human beings and animals are provided with natural safeguards against disease germs and their toxins. We have also learned how the body can be provided with prepared antitoxins that will destroy certain toxins. But there are diseases for which no antitoxin has been discovered except that produced in the human body itself. In some diseases these natural safeguards are not powerful enough to resist successfully the work of the germs. In smallpox, for instance. the germs often overcome all resistance.

Not many years ago smallpox was very common. Its ravages were frightful. Even to-day there are occasional outbreaks of the disease. It is very contagious. The germs are scattered about by coughing or sneezing or touching the patient and are left on anything the patient touches. Quarantining by health officers has done much to check the spread of this disease. But the greatest progress has been made by vaccination.

Many years ago, before anything was known about germ diseases, it was discovered that cattle

can be given a kind of smallpox. Sores break out on the skin of the animals as they do on human beings. But the germs are weak and do not spread from one animal to another, as they do in smallpox in man. Some of these weak germs are gathered from a sore of an affected animal. This preparation is called *vaccine* from the Latin word *vacca*, meaning "cow." In vaccination, a person's skin is scratched and a little of the vaccine rubbed into the wound. By this means, the weak smallpox germs find their way into the blood. Soon thereafter symptoms of a mild attack of smallpox are developed, which, however, is not contagious. An anti-smallpox substance is produced in the human body that is strong enough to protect one from the more violent form of the disease.

Vaccinating a child

What is immunity? If a person recovers from certain contagious diseases like smallpox, scarlet fever, whooping cough, measles, mumps, yellow fever, or typhoid fever, he is said to be immune

from those diseases. That is, he rarely has such a disease a second time, because the antitoxin and other curative and preventive bodies guard against any future attack. On this principle of immunity is based the practice of vaccination. When a person is vaccinated he passes through a slight attack of the disease. The body forms safeguards and thereafter he is immune from that disease.

Immunity, however, does not last a lifetime. Gradually the preventive substances lose their power to resist germs. It has been discovered that human beings should be revaccinated every few years in order to remain immune.

Vaccination is also practiced in cases of hydrophobia and typhoid fever. The germs of hydrophobia, which are usually spread from the bites or scratches of dogs and cats that have hydrophobia, attack the brain and spinal cord. The practice of vaccinating in cases of hydrophobia was first used by the French scientist, Pasteur. As in smallpox, so also in hydrophobia, weak hydrophobia sera are injected into the blood to give the body power to kill invading germs. Our sailors and soldiers are made immune to typhoid fever by the injection of weak typhoid germs.

What are some of the common germ diseases of the skin? The most common diseases of the

skin caused by germs are pimples, boils, and carbuncles. These affections of the skin are caused usually by a bacterium of the spherical form (micrococcus). It is called *staphylococcus*, from the Greek word *staphylo*, meaning "a bunch of grapes," because the bacteria live in bunches or clusters. The peculiarity of these bacteria is that they form pus in the part affected. They attack the mucous membranes as well as the skin, causing swellings often attended with great pain and fever. Similar germs are often found in wounds and internal inflammations, as in appendicitis and tonsilitis. They sometimes cause blood poisoning.

What is the difference between a boil and a carbuncle? A boil has only one opening; a carbuncle has many. Boils may come at any period of life; carbuncles usually occur after the age of forty. Boils may come on any part of the body, while carbuncles prefer the back of the neck. Boils come to a head in a short time and after discharging speedily recover. Carbuncles persist much longer, involve large areas, disturb health, and often prove fatal. Boils are painful but as a rule not dangerous. One with a carbuncle should always be under the care of a competent physician. Boils may be treated with moist dressings until they soften and discharge or are opened with the k

What is scabies? The common name for this annoying infection is *itch*. It is not caused by a bacterium but by an animalcule (very small animal), *Acarus scabiei*, which burrows under the skin. The principal symptom is severe itching, which is generally worse at night. The scratching produces secondary lesions (injuries) which often resemble eczema. There are no curative bodies produced which limit the life of these organisms and hence, unless treated, the disease may last for months. It is usually confined to the hands. It is very contagious, passing from the infected to the uninfected hand. It may also be conveyed indirectly through articles (knives, marbles, gloves, bedclothes) which have been in contact with the infected person. The female mite is much larger than the male and is visible to the eye. Sulphur is one of the best scabiecides (mite killer). It is applied to the infected parts in the form of an ointment (composed of lard, balsam of Peru, beta-naphthol, vaseline, and precipitated sulphur). Styrox and lard form a good preparation for scabies in children. Any druggist will put up these preparations.

What is eczema? This disease occurs most frequently on the face, hands, and legs. It causes roughness, scabs, and sores and is attended by severe itching. The various forms of eczema

are supposed to be caused by germs, but the cause is not yet fully determined. Indigestion, overeating, and faults in diet are indirect causes of this trouble.

There are of course many other diseases of the skin. Skin diseases are commonly spread by contact, more particularly by using the same towel that some one with a skin disease has used. For this reason it is safest never to use a public towel.

What is meningitis? The meninges are the membranes enveloping the brain and spinal cord. The disease called meningitis is inflammation of those membranes caused by a variety of the pus-forming bacteria, or by the germs of other diseases such as typhoid fever, pneumonia, tuberculosis, and influenza. In the epidemics of meningitis which sometimes visit our cities, it has been discovered that the disease is caused by a germ called *meningococcus*. The disease is contagious and is the cause of a large number of deaths every year. It is most often spread by "meningitis carriers." The germ usually gains entrance to the brain and cord through the mouth and nose.

From the blood of a horse inoculated with the *meningococcus*, a serum has been prepared which is of great value in curing the disease in human beings.

What is infantile paralysis? Infantile paralysis is the result of an infection of the spinal cord, by germs, causing paralysis. It attacks children principally, often leaving those who survive it crippled for life. Grown persons may also fall victims to it. Many persons, during an epidemic of infantile paralysis, while apparently well, carry the germs of the disease in the secretions of the mouth and nose, and are capable of spreading the disease to others. Doctors have tried to find a means of checking it, and health officers quarantine against it. No one has yet discovered a remedy for this dreaded plague so wasteful of child life.

There are many other diseases evidently caused by germs, but the specific causes have not yet been discovered. Among them are rheumatism, measles, mumps, and scarlet fever. The great danger in cases of scarlet fever is that the pus-forming germ usually attacks the body together with the scarlet fever germ. Frequently internal organs are affected, leaving disorders that last a long time, sometimes for life.

DISEASE GERMS AND DISINFECTION

What is disinfection? When a child has been sick with any of the diseases mentioned, there is a probability that the germs of the disease may linger in the room for a long while. The

most important means of spreading infectious diseases in general (there are exceptions) is by contact with the sick or with carriers. The principal points of discharge of germs from the sick and the carrier are, first, nose and throat, by far the most important; second, intestinal tract; third, genito-urinary tract. In order that people going into the room may be guarded from dangers of infection, it is required that all rooms in which people have been sick with contagious diseases be disinfected. And more particularly the bedding, clothing, and all other things used in or about the sick person must be disinfected. This is accomplished in various ways.

How can we destroy germs? A number of ways have been found in which germs may be destroyed without much difficulty.

First we must understand that germs cannot come into existence of themselves. Germs may grow and multiply in the soil, in the air, in food, or in water. Mosquitoes and flies may carry them. We must also remember that disease germs are present in the bodies or on the skin of persons who are perfectly well. So we can understand the great importance of cleanliness for all, whether sick or well. In many cases cleanliness alone is not enough to prevent the spread of disease germs. We must take extreme measures and kill germs, wher[illegible] they

are found, by means of disinfection. There are two standard methods of destroying these pathogenic (disease-producing) organisms—by poisons (chemicals) and by heat.

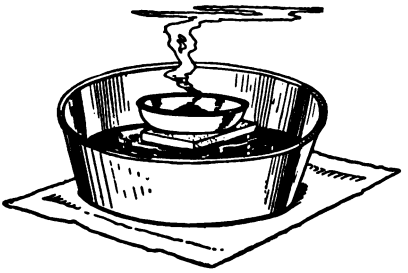
How are germs killed by poisons? There are a number of chemicals which are useful in destroying germs. Disinfection by means of chemicals is employed by health officers in checking epidemics of contagious diseases. Chemical disinfectants are poisonous if taken into the body and great care should be used to label them correctly in order to avoid mistakes. They should never be put where children can get at them.

Housewife disinfecting with chlorinated lime

What is fumigation? One of the most common, yet perhaps least efficient, methods of disinfection is *fumigation*. In order to fumigate a room a substance must be used that will produce fumes or a gas. Burning sulphur produces strong fumes that fill the air and so

enter into every crack and cranny and thus destroy the germs.

What is the method used in fumigating with sulphur? To fumigate thoroughly a room that is ten feet square and ten feet high it is regarded as necessary to burn three pounds of sulphur. In order to fumigate a room, the sulphur is first placed in an iron or stoneware vessel. The vessel is then set on a brick placed in a tub containing a little water. After all cracks and openings which would allow the gas to escape have been carefully sealed, the sulphur is set afire. The person who does this must leave the room immediately and close the door after him.



Fumigating with sulphur

To make the fumes more effective, pots of boiling hot water are placed about the room to fill the air with steam or water vapor. This vapor absorbs the sulphur fumes and holds them for a long time. The room should remain closed for twenty-four hours, and then be opened and aired out thoroughly.

Though once a popular method, sulphur fumigation is but little used at present.

How is formaldehyde used in disinfecting? A liquid solution of formaldehyde (formalin, containing 40 per cent formaldehyde) can be made and sprinkled about the room, which should be closed up as tightly as possible and left for several hours. The liquid evaporates and a gas will be thrown off. This gas will kill germs of tuberculosis, typhoid fever, diphtheria, and other deadly bacteria.

What are good disinfectants? Solutions of carbolic acid (phenol), the cresols (tricresol, creolin, lysol), mercuric chloride (corrosive sublimate), chlorinated lime (bleaching powder), and iodine dissolved in a solution of potassium iodide are all good disinfectants. Carbolic acid is sprinkled on matters which are to be sterilized, and chlorinated lime is used largely in sterilizing drinking water.

How may body wastes be disinfected? We have read that one cause for the spread of disease germs is the pollution of the soil or of water by body wastes (pages 119–121). It is very important that the germs present in the body wastes should be destroyed. Chemicals used for that purpose are carbolic acid in solution, chlorinated lime, quicklime, compound cresol, and similar bodies. These are very effective germ killers. Compound cresol is most useful in disinfecting the sputum of pneumonia or

tuberculosis patients. A cesspool may be disinfected by pouring into it a solution of chlorinated lime made of a little over an ounce of the lime to a gallon of water.

How may we disinfect the skin? We know that those who come in contact with persons who have germ diseases as well as the patients themselves are likely to carry the germs on their hands. So it is a very important thing to disinfect the hands frequently. Washing with soap and hot water is the best means of disinfection, but it is well also to place the hands in a special disinfectant. Nurses and surgeons sometimes use a weak solution of bichloride of mercury, permanganate of potash, or iodine for this purpose.

What is Nature's disinfectant? There exists in nature a very powerful disinfectant without whose aid men and animals would soon be destroyed by the increasing myriads of disease germs. This great natural disinfectant is sunlight. Vast numbers of germs in the air and in water exposed to sunlight are destroyed by it. In certain diseases of the skin, rays of light have been used successfully in checking the growth of the disease germs.

Another effect of sunlight is to dry out everything upon which it shines. Drying is very effective in killing germs, though there are

certain kinds that resist drying. A damp house offers the best conditions for the growth of germs and is a dangerous place in which to live. "Where the sun does not go, the doctor does."

The best, modern way to disinfect a room is to clean it thoroughly, scrub out with soap and water, and air thoroughly, letting in all the sunshine possible.

What is the effect of heat on disease germs? Germs are quickly killed by heat. Boiling water is a most useful disinfectant. Clothes and dishes may be thoroughly disinfected by boiling. The process of cooking destroys all dangerous disease germs that the food may contain. Heat is the best and safest method of disinfection. Large steam sterilizers that look something like steam boilers are used in hospitals for sterilizing such things as bed ticks and bedclothes. These vessels are very strong so they can resist the pressure of steam. The steam may be admitted directly in contact with the articles to be sterilized or it may be held in a jacket. In the latter case the process is called sterilization by dry heat. When dry heat is employed a higher temperature and longer time are required than otherwise.

What is an antiseptic? The word *antiseptic* comes from two Greek words meaning "against putridity" (decay by means of bacteria). An

antiseptic is used generally before germs have begun their work on the tissues. It prevents the growth of germs in wounds or sores, particularly the pus-forming bacteria (page 146). A disinfectant is usually very much stronger than an antiseptic and differs from the latter in not being intended for use upon the living body. An antiseptic does not necessarily kill the germs. Freezing cold is a good antiseptic and foods are kept for a long time in cold storage.

Thus we see that though we have countless enemy germs, nature and science have given us safeguards which, together with habits of personal cleanliness, will often protect us from them. If all persons were educated in rules of right living and kept them, if poverty and intemperance in eating and drinking were banished from the earth, it would be a simple matter greatly to reduce all germ diseases. But this condition of affairs will probably never be realized. It is important therefore to take all possible precautions against infection.

QUESTIONS TO HELP THE PUPIL

1. What are microbes or microörganisms? 2. What is the difference between bacteria and protozoa? 3. What different shapes have these minute organisms? 4. Name some bacteria that are helpful to man and show how they are helpful. 5. Name some that are harmful and show how they harm. 6. How and where do bacteria live? 7. How do they multiply? 8. What sort of wounds are

most favorable to the tetanus bacilli? 9. What medical treatment should such wounds receive?

10. What are toxins? 11. What are antitoxins? 12. Describe how antitoxins may sometimes be prepared artificially. 13. Why should the physician care to have these artificially prepared antitoxins, when they form anyhow within the bodies of persons who are ill with infectious diseases? 14. State whether the antitoxin that is used in one disease can also be used in another. 15. For what diseases have antitoxins been prepared? 16. What is vaccination? 17. Why does the government wish all children and all soldiers to be vaccinated? 18. Exactly what takes place when a person is vaccinated? 19. When is a person said to be immune to a disease? 20. How does he become so? 21. How long does immunity last?

22. What causes some of the common skin diseases? 23. Define boil; carbuncle; scabies; eczema; meningitis; infantile paralysis. Tell what you can about each. 24. Name several ways of killing germs. 25. When may you use heat in disinfecting? When poisons? 26. What poisons are used and how? 27. What is the difference between a disinfectant and an antiseptic?

XIV. Protecting the People from Ill Health

How are pupils in public schools protected from children's diseases? Measles, whooping cough, croup, diphtheria, and scarlet fever are often called children's diseases. This does not mean that grown persons never have them. They often do. But these diseases are common chiefly among children. Many persons think that children must have them. A fond mother said to the writer not long ago, speaking of her daughter, "Louise is six. I am going to send her to public school." My reply was, "Do not send her for a year or two. Let her enjoy outdoor life and play." "No," she responded, "I am going to send her right away. I want her to have whooping cough and measles just as soon as possible."

Many mothers look upon the public schools as clearinghouses for children's diseases. It is not necessary that children have these diseases. They never have them unless they contract or "catch" them from somebody else. Hence the health officer protects well children from the sick by *quarantine.*

What is quarantine? When a child becomes ill he is taken out of school and kept away from

other children. In certain cases, even in his own house, he has a separate room and nurse and even other members of the family are not allowed to visit him. Whenever any one is safeguarded in this way he is said to be *quarantined.* A child is quarantined in order that he may be prevented from giving the disease which he has to anybody else. In most cities the law requires all children suffering from contagious diseases to be quarantined. In Washington the laws permit a child with whooping cough to be taken into the street provided he does not go near other children. With measles and diphtheria children are usually too ill to go into the street. With diphtheria, especially, even the father and mother, if they are not nurses, are not allowed to see the child. The one who goes into the child's sick room must stay there on account of the danger of carrying infection. Even the doctor who visits the child disinfects or kills the germs on himself and his clothing before he goes to any other home.

In severe cases the patient is removed to a hospital, usually public, called a contagious disease hospital. Here he is kept in a room apart from the others, where only patients with that disease are being treated. These public hospitals are under the management of the health department of the city or county. Here

patients are cared for, sometimes entirely free of charge, if they cannot afford to pay for private medical treatment.

How dangerous are these diseases? There is danger to children in all these diseases. The young child, especially, does not have the resistance of the older child or the grown person. That is, his power to keep well in spite of disease germs is not so great. Hence he may succumb to a disease which, if he were older, he might overcome. The most dangerous of children's diseases are, first, diphtheria or its near neighbor croup; second, scarlet fever; third, measles; and fourth, whooping cough. Many children die every year from these diseases which their mothers often want them to have. The particular disease may not be fatal to the child. He does, however, have a tendency to contract other diseases which follow in the wake of those mentioned. In common language these are called *sequelae* ("followers"). Thus pneumonia, heart trouble, tuberculosis, or some similar disease may follow the children's diseases. This is due to the fact that the resistance of the child who has been sick has been so reduced as to favor the development of these other diseases.

How are these children's diseases contracted? These diseases of children are always c

by actual infection from a diseased person. It is not even necessary to touch persons who have certain diseases in order to get the same sickness. If we go into a room where a child has whooping cough the germs from the throat may be floating through the air, having been expelled or driven out during coughing. Or we may take hold of some object on which these germs have been deposited. We may ride in a street car where a child has been coughing and the germs are still left floating in the air or attached to some part of the car where we may acquire them. Sometimes it seems that a child's disease starts up of itself, but this is never the case. The cause of the infection may be unknown, but it nevertheless exists.

How long after exposure is it before the child is ill? The time elapsing between the exposure of the child and the time when the disease breaks out is called the *period of incubation* (hatching). The time required for the development of measles is ten to fourteen days. The disease lasts usually about two weeks. The time required for the development of whooping cough is from two to ten days. Whooping cough lasts about eight weeks. The time required for the development of scarlet fever is from two to eight days, and this disease lasts from two to three weeks. The time required for the development

of diphtheria is from two to ten days. Diphtheria is a very quick disease, and in cases of recovery lasts from one to two weeks. Other children's diseases, which, however, are quite common to grown people, are mumps and chicken pox. The disease known as mumps is ushered in by a painful swelling under the jaw. The average duration of the incubation is about two weeks. Chicken pox has an eruption which resembles smallpox in some respects. The time of incubation is from one to two weeks.

For how long a time can these diseases be communicated? Generally when the sickness is well over and the child is recovering, the danger of communicating the disease to other people is not great. In some circumstances, however, this ability to communicate the disease lasts a long while. For this reason the child should be kept in quarantine for a considerable period after all evidences of the disease have disappeared. By enforcing the quarantine the health officer is most successful in preventing the spread of diseases of this kind.

Why should schools be inspected by a medical officer? The schools are the most favorable places for contracting disease. The medical inspection of schools is of the greatest importance to the public health. A thorough medical inspection of all the schools in the United States

which would exclude from the school all children who have colds, sore throat, and early symptoms of disease, would save thousands of valuable lives every year.

What is the value of dental inspection? The dentist is just as important to the welfare of the school as the doctor. The teeth of school children have important relations to health. If the teeth are irregular or decayed it is impossible to chew the food properly and weakened digestion may follow. The infection or poisoning by germs of decay (for decay is caused by bacteria) may easily be conveyed to children whose teeth are sound. More serious infection due to the bad teeth may take place within the body. Rheumatism, heart trouble, tonsilitis, and pneumonia may be favored or even brought on by bad teeth.

The breath of a child with bad teeth becomes foul and his playmates avoid him. Bad teeth seriously interfere with good behavior and scholarship. Dental inspection maps out the diseased teeth. The child takes the chart home to his parents, who perhaps have not known that his teeth were in bad condition. The father takes the child to the dentist. As a result his teeth, health, deportment, and standing in his class are all improved. Bad boys become good when their teeth are put in good

condition. Poor pupils sometimes go to the head of their class when their mouths are put in proper condition.

How does the state protect our health? We do much toward keeping ourselves in good health by forming good health habits. In so doing, we also protect the health of others. When we keep our yards free from rubbish and our houses clean, the air in the neighborhood is kept free from bad odors and we benefit all our neighbors. When we have a cold and we cough or sneeze, we hold our handkerchiefs to our mouths and noses. Thus do we protect others from catching colds. The city or state should require us to do all these things.

But there are many persons who do not know how to take care of their own health and are careless of the well-being of others. From such persons we need protection. They must be required to do certain things and forbidden to do certain other things in order to safeguard the public health. One of the principal duties of a government is to protect the health of its people. This it does by means of laws and regulations which all must obey.

What is a board of health? A board of health is a department of the government which takes care of the public health. Every large city or town has a board of health. The m of

this board make rules of health that must be followed by all who live in the city or town. In general, it is the duty of the board to see, so far as it is able, that the food the citizens buy is good and wholesome. The air they breathe in the home or on the streets must be as pure and as free from dangerous germs as it is possible to make it. No harmful microbes may lurk in the water supplied to the people. These tasks are performed with the help of other departments of the government. In fact, all departments of a well-ordered government work together for the safety, welfare, and good health of the citizens. Among those organizations that work with the health department are the bureau of streets and alleys, the water department, the department of sewers, the playgrounds department, the building and housing department, and, in some large industrial centers, the bureau of smoke prevention. The police force also renders most valuable assistance.

How do the departments work for the public health? The bureau of streets and alleys keeps the streets clean by sweeping and flooding with water, and clears the gutters of dead leaves and refuse. In summer it oils or sprinkles the streets to keep the dust caused by automobiles and wind from filling the air. An unpaved street is always dustier than a paved one. So

it is to the interest of the public health for the department to extend the paved area of the city as much as possible and see that all damaged paving is promptly repaired. A branch of this department also removes garbage and rubbish which, if left lying in streets and alleys, would fill the air with germs and bad odors. Horse dung, if left in the streets, provides breeding places for flies which may carry disease into the homes.

A street cleaner at work

The water department provides the citizens with a plentiful supply of water for drinking, bathing, and general cleansing purposes. Every day in well-governed cities a member of the board of health examines the water at the pumping stations to see whether it is fit to drink. If dangerous bacteria are found, steps are taken to purify it with chemicals, filtration, or both. Citizens are at once warned that suspicious water

boiled before it is safe to use. A sudden rush of rainwater will wash great quantities of bacteria into any exposed water supply. If it is possible for sewage to reach the water the danger from impurities becomes a certainty. In rainy weather following a drought a well-conducted water department will take unusual pains to purify the water and warn the people.

Another thing every up-to-date department does to prevent the spread of disease is to secure and enforce laws forbidding the use of common drinking cups and towels in public places. The mouth, more than many other organs of the body, is a loafing place for harmful germs. Experts who have made a study of germ diseases tell us that in our mouths may be found the germs of diseases we have never had and from which we are not suffering. These germs we deposit on the drinking cup and pass on to the next person who uses it. If his system is in a somewhat weakened condition, he will be unable to resist the attack and will fall a victim to the disease. In much the same way, infection is spread by the public towel, with its coating of dirt and germs transmitted through contact with the skin. Health departments have discovered that some of the most terrible diseases from which mankind suffers are passed about from one person to another through these two agencies.

Accordingly, they insist on the use of individual towels and drinking cups conveniently made of paper. The bubbling drinking fountains which have become so common are now known to be very insanitary, unless frequently disinfected with care. The parchment drinking cup, used once and thrown away, is the safest.

The proper way to drink from a sanitary bubbling fountain

The department of sewers builds and keeps in order a system of underground drains that carry away the waste from toilets, kitchen sinks, gutters, factory drain pipes, and the like. Some cities allow their sewage to empty into a neighboring lake or river. This practice spoils the water for human use and kills the fish. Some progressive cities, however, have adopted the plan of purifying their sewage with chemicals, forming sludge (water-soaked mud) and using it as a fertilizer. Instead of poisoning the air and the water supply, this waste matter can be used to enrich poor soil and make crops grow. A good method

of sewage disposal is to carry it on to barren, sandy soils, which by this means are made fertile.

In the crowded cities where pure air is not always easy to get, the recreation department provides the people with breathing places in the form of parks and playgrounds. These places, when large enough, are planted with grass, trees, and flowers. These are cultivated not only for their beauty, but for their health-giving qualities. We have learned that plants are continually giving off oxygen and absorbing carbon dioxide gas from the air. We know also that

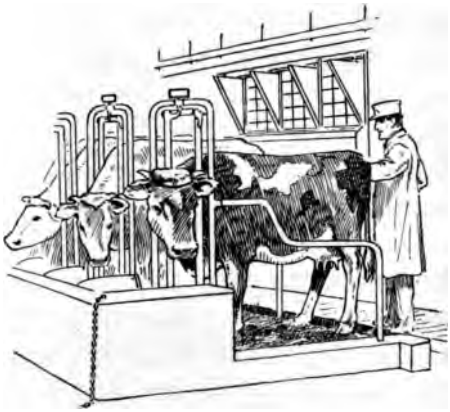
A city playground

human beings must have an abundance of ı and must get rid of the carbon dioxide

gas in their systems. So we can see what a fine medicine Nature has stored up for city people in their parks and playgrounds. Many park boards supply these places with swings, row-boats where there are ponds, tennis courts, sliding boards, parallel bars, rings, and other playground apparatus. They sometimes add a well-equipped gymnasium for use in cold weather. Thus the city provides for those who, after their work is done, have no private means of outdoor recreation. Here they may come to rest or to strengthen their bodies by proper exercise.

What are the duties of the food inspector? The health department renders no public service more important than the sanitary regulation of foods and beverages sold within the city. Inspectors make the rounds of the local markets to see that no bad meats, decayed vegetables, diseased fruits, or adulterated groceries are exposed for sale. They keep a watchful eye on bakeries, candy shops, restaurants, and similar places where cooked foods are handled. They inspect soda fountains and other places where "soft" drinks and ice creams are served, to protect the people against unclean handling and harmful adulterants. They demand that all these places shall be kept clean, well ventilated, from dust and flies. Special attentio

to dairies and milk-bottling establishments, for every good health officer knows that the lives of very small children depend upon the purity of the milk they drink.



A health inspector at work in a dairy

In the United States, as in no other country, ice is used with food and often taken into the system, sometimes with the liquids we drink. So it requires the strictest inspection. It is the duty of the health department to see that the streams and ponds from which it is cut are fit for use, and that the storage houses are kept clean. But ice should never be put into the liquids we drink. It should be applied only to the outside of the vessel containing the liquid.

Why is overcrowding in a city dangerous to health? One great danger to health in the city is caused by overcrowding. In the business and factory districts of many cities, every available square foot of space is occupied by buildings. There is no room for grass or trees. The buildings, crowded close together, tower high, thus

shutting out the sunlight. The streets and the buildings are filled with people, some neat and careful in their habits, others dirty, ignorant, and careless of the needs of themselves and others. For this reason diseases are spread more easily in the city than in the country where the air is pure and the population more scattered.

When many people live in a small space, the homes, especially those of the poor, must be small. A great many of these people work in factories and stores at low wages. They must live as cheaply as possible in order to get food and clothing. For this reason, they seek cheap lodgings, usually in the *slums*.

What are slums? In some parts of large cities are rows of old houses called "tenements" because they are occupied by two or more families living independently of each other. Usually they stand in or near the factory district where the air is tainted by smoke and gases. As the rent is cheap, the poor people flock here to live. These groups of wretched tenements are called *slums*. The houses are divided into tiny rooms, most of them without proper light or ventilation. Some of the rooms are without a single window. Others, far below the street level, are often flooded with fil water that has leaked from broken drain pi

In such unhealthful surroundings, sometimes as many as eight persons live in a single room.

How does the building and housing department help? From what we have learned of the need of light and air, and of the way diseases are spread, we can understand why slum dwellers have died by the thousands. Sometimes entire cities have been swept by epidemics which started in their slums. It is not many years ago since these conditions were brought to the attention of thinking people. City governments at last took action to clean up their slums. Building and housing laws were made which laid down rules for the construction of tenements and workshops, and a department sprang up to enforce these laws. In New York state especially, where the worst cases of overcrowding may be found, builders of tenements were compelled to allow not less than 400 cubic

A sleeping room in a tenement

feet of air space for each person. The least amount of air space required for workshops was 250 cubic feet. Many old tenements were torn down. New sanitary houses were erected in which every room had a window opening out of doors. Insanitary plumbing, vaults, and sinks were abolished. In planning the size of yards, rooms, window space, and the like, builders were forbidden to go below certain measurements. Thus ventilation and lighting were much improved. Better forms of fire escapes were demanded and certain parts of the building, as stairways, had to be fireproof. The laws made it hard to build tenements over six stories high, especially on narrow streets, where tall buildings shut out the light and air and are dangerous in case of fire. No such buildings should be allowed unless strictly fireproof.

What are the duties of health inspectors? In some cities the health department sends out inspectors to examine the homes especially of the poor people. When windowless rooms, broken plumbing, unclean walls and floors, and filthy cellars are found, the owners of the buildings are forced to put things in order. Many landlords do not care about the welfare of their tenants. They only want to make as much money as possible out of their houses. But all are obliged to obey the law.

Many of the persons living in the tenements do not know that disease germs are to be found in dirt and refuse. They do not know how dangerous it is to live with sick persons in unventilated rooms. The inspectors are told to teach the people these things. It is hoped that a great change soon will come. With improvement in the homes and education of the people, the general health will improve. By their attention to sanitation, city governments save thousands of lives.

It is known that many people living in the wretched surroundings of the slums are indifferent and will not obey the laws. The prisons and asylums are filled with persons who have come from the slums. But now under changed conditions, the poor people gain new courage. They work better and are more careful of themselves and others. Thus besides lengthening the lives of many of the poor by their health laws, cities reduce crime and make useful, happy citizens. Not only in the cities but also in many counties in the country districts visiting nurses are found who go to the ill or unfortunate and teach them the value of cleanliness, wholesome food, and bathing. They also show them how to care for the sick.

This work has been carried even further. Many cities take greater pains than ever before

to keep their crowded districts clean. Wherever it is possible, special playgrounds are opened in slum neighborhoods. Occasionally the people are taught the value of cleanliness through the opening of free public baths. In Washington there is a public bath during the summer in the Potomac River. Health officers are always in attendance to prevent any one with a loathsome or contagious disease from going into the water.

In the workshop as well as in the home, sanitation laws are enforced. Factory inspectors are appointed whose duty it is to see that the surroundings of the workers are clean and wholesome. Shops and factories are required to be well ventilated and lighted. Workers are not allowed to labor more than a certain number of hours, and fines are imposed upon employers who demand more hours than the law allows. All these measures have greatly improved the health of the workers as well as the quality of their work. Thus, both employer and employee are benefited.

How do we get rid of the smoke nuisance? A number of cities that are centers of trade and manufacturing have been forced to consider the problem of how to get rid of their smoke. Out of their efforts have grown departments of smoke prevention. It is the business of these

departments to guard the public health against this dangerous pollution of the air.

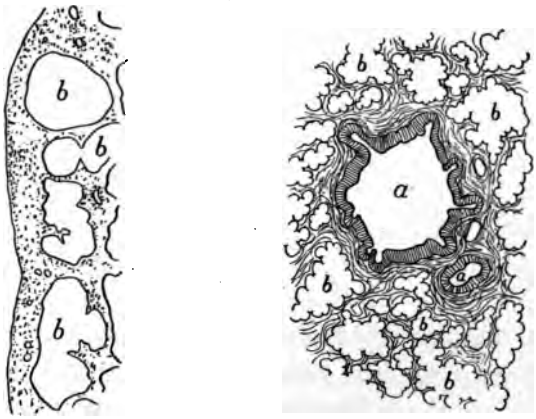
Many people do not realize the seriousness of this evil. The smoke that pours from chimneys and smokestacks in manufacturing and railway districts is filled with poisonous gases. In the burning of coal, large quantities of a gas called sulphur dioxide are thrown off into the air. This gas destroys trees and grass and flowers. The smoke also contains a vast number of carbon particles. When breathed in, these particles leave black deposits in the tissues of the lungs (see page 65). Even arsenic is sometimes found in smoke from burning coal.

The avenues through which the breath passes do all in their power to protect the lungs. The lining of the nostrils is fitted out with a multitude of minute, hairlike filters, which seize and hold back as much of the stream of soot as possible. Guarding the entrance of the bronchial tubes, stands an army of little sentinels—the cilia, shaped like tiny fingers. Back and forth they swing unceasingly as long as life lasts, driving the invading black particles upward toward the mouth. The stream of mucus, secreted by the soft membrane lining the air passages, catches them up and sweeps them away in the same direction. Then there are the phagocytes, of which we have learned on page 87. These

"sanitary engineers of the blood," as one authority calls them, stand ready to seize and destroy any harmful substances that come their way. But the faithful sentinels cannot turn back or destroy all the invaders. For in some cities, tons of soot are deposited every day, so human beings cannot escape the deluge. Numerous carbon particles sift into the lungs, streaking and spotting their pink lining with black. In the lung walls are cells through which passes the oxygen that purifies the blood. The soot blackens and clogs these cells until they cannot do their work, and the body is thereby weakened by having its supply of oxygen partly cut off. Thus it may easily become the prey of every disease with which it comes in contact, particularly the dreaded "white plague," tuberculosis.

So it is the task of the smoke prevention department to prevent the clogging of the lungs and the poisoning of the air by smoke. There are several methods by which this result may be obtained. Devices may be used which almost entirely consume the dense clouds of smoke rolling from locomotives, factories, and boats. Also, by certain methods of handling the fires in the furnaces, much of the smoke may be "burned up." Smoke inspectors go about teaching firemen how to manage their fires.

They also enforce the laws providing for the use of smoke-consuming appliances. Finally,



The effect of smoke on the lungs

A, cross-section of the lung of a miner, showing pigmentation of the lung; *B*, cross-section of the lung of a healthy child; *a*, bronchial tubes; *b*, lobules

some cities are insisting that the railways run all their engines by electricity within city limits, thus doing away with locomotive smoke altogether.

What are vital statistics? Another function of the health department is to supervise the work of collecting *vital statistics*. These are public records of the births, deaths, and diseases occurring among the people of given localities. Such records are kept in all the leading countries of the world. But there are many parts of the United States where vital statistics are not

kept. This is a great mistake, as they are very important in the work of guarding the public health.

What is the value of vital statistics? If the health records of a town or city show that there are a great number of deaths from disease, it is clear that there is something wrong. The water supply may be filled with dangerous bacteria. Persons suffering from contagious diseases may not have been kept in quarantine. The air may have been poisoned by decaying waste matter that should have been removed. In every case, the records will point out to the health officers what the trouble is, so that they may improve conditions.

After the evil has been located and measures taken to remove it, the vital statistics will then show whether the work has been successful. If it has, the number of sick persons will immediately grow less.

Nothing better illustrates the various duties of the health department and the use of vital statistics than the campaign which city, state, and national governments have carried on against tuberculosis. We have learned that tuberculosis is more destructive to human life than any other disease (page 33). This knowledge came to us partly through a study of vital statistics made by able physicians and [illegible]tists.

They found that tuberculosis kills over 150,000 persons in the United States each year. For years they labored to understand the disease and to work out successful methods of treatment. Their investigations upset the popular belief that people suffering from tuberculosis cannot be cured. Health departments everywhere profited by their studies and coöperated with them. As far as possible, the methods they recommended for checking the disease have been adopted.

What is tuberculosis? These investigators discovered that tuberculosis is a disease caused by germs which, in about ninety per cent of the cases, are carried from one person to another. Hence precautions to prevent the spread of the disease from person to person are most important. These germs not only attack the lungs but may grow in almost any part of the body—for instance, the intestines, the larynx, the kidneys, the skin, or the bones. But the form that causes the most deaths is pulmonary (lung) tuberculosis, or consumption. The germs enter the body in three ways. First, they may be inhaled in the form of a moist spray caused by the coughing, singing, laughing, or sneezing of the patient. Secondly, they may be swallowed in food, as in milk. Thirdly, the germs may be lodged in open cuts or bruises.

What has been done to prevent the spread of tuberculosis? The investigators found that, under ordinary conditions, the *tubercle bacillus* (page 33) does not grow and multiply except in the tissues of human bodies or those of the lower animals. They investigated the conditions that favor the spread of this germ. On their reports the city governments based their laws to guard the public health.

It was pointed out that great danger lies in the habit of spitting in public places. Most of us have seen notices in street cars and public buildings saying: "Spitting on the floor is prohibited. Offenders are liable to arrest." These notices are posted by health officers. In New York and other cities offenders are made to pay a heavy fine for disobeying this rule. In some cities, spitting on the sidewalk is prohibited. When a consumptive spits or coughs, he sends thousands of germs into the air, to endanger the lives of any who may be near.

The investigators also discovered that cattle may have tuberculosis and that the germs may be present in the meat and the milk (page 34). Food inspectors were instructed to stop the sale of the meat of tuberculous cattle. Dealers in milk were required to purify the milk by heating it to a certain temperature. This process makes harmless most of the disease germs that may

be present. It is called *Pasteurization*, from Pasteur, the name of the man who discovered it.

How were the people educated to guard against it? The most effective part of the campaign against tuberculosis has been the work of education among the people. Health departments, anti-tuberculosis societies, medical societies, and charitable organizations united in teaching the public how to guard against the dread disease. It was shown that fresh air and sunlight will destroy the tubercular germ as well as the germs of other diseases. Tuberculous patients were therefore encouraged to live in the open air as much as possible. They were warned against "quack" medicines and nostrums or patent medicines, many of which contain alcohol. Alcohol is one thing that tuberculous persons should not use. Statistics show that the use of alcohol lessens the body's natural ability to resist the germs of disease. When the system is "run down," certain tonics like cod liver oil may be valuable to nourish and strengthen it. But it is a great mistake to assume that the disease can be cured by the use of drugs.

What precautions should be taken? Those who assist in educating the people lay great emphasis upon a proper diet. This should be especially nourishing in order to provide the blood with vigorous organisms with which to

destroy the tuberculosis germs. Pure milk, eggs, whole wheat bread, fresh vegetables and fruits, with meats of healthy animals, form the ideal diet.

Plenty of sleep in the open air, freedom from worry, and only gentle exercise are other essentials. If an outdoor sleeping room is impossible, then the patient should sleep in a well-ventilated room by himself. Also his bed clothing should be aired every day and disinfected frequently.

A person with tuberculosis should hold a handkerchief before his face when he coughs. His handkerchiefs should be disinfected by boiling. The sputa should be received in a special paper vessel and burned. His dishes should be kept apart from those used by other members of the family, washed separately, and boiled before being used again. Also the person handling a tuberculous patient should disinfect his hands.

Such are the chief precautions to be taken to conquer the disease. A strict observance of these rules makes it possible for a well person to care for a tuberculous patient without becoming infected. Tuberculosis, if taken in time, is curable. Neglected in its first stages, however, it will prove a stubborn foe to overcome.

Other measures have been adopted to check the growth of tuberculosis. Public and private hospitals and sanitaria for tuberculous patients have been established in various parts of the

country. Open-air schools for tuberculous children have been opened in large cities like New York and Chicago. It is noticed that those who attend improve rapidly in health and in the quality of their school work.

The ravages of tuberculosis are already decreasing. Nevertheless, in the task of exterminating it there are great obstacles to overcome—poverty, bad housing, ignorance, and alcohol. But the efforts of health departments, with the campaign of education, are slowly making headway against this enemy of mankind.

PUBLIC HEALTH IN THE COUNTRY

Why is it usually more healthful to live in the country than in the city? It is more healthful to live in the country or the small village than in the city because country air is generally free from the smoke and gases of factory fires and the dust of city streets. Country people live more in the open air and are not crowded together. For this reason, vital statistics show often a smaller number of deaths from contagious diseases in the country than in the city. Diseases of the lungs and throat are less frequent. The clean air and the sunshine lessen the danger from pneumonia and tuberculosis. But in a few states the death rates are higher in the rural districts than in the cities. Persons may

live there amid surroundings just as unsanitary as any in the city. Some persons do not understand the value of fresh air, and so keep doors and windows tightly closed.

What is the chief danger in the country? Vital statistics show that those who live in the country are more in danger of typhoid fever than those who live in the city. The cause of typhoid is usually a polluted water supply. As a rule, the city dweller can be sure that the water supplied to him has been carefully examined and, if necessary, purified. The city sewage system also is generally so planned as to carry off all waste. But the country dweller has a more difficult problem to solve. He must provide his own water supply; and if he is not awake to the dangers of infection from germs, he will be exposed often to serious illness from drinking impure water. In the country, wells are frequently located at lower levels than cesspools, barns, outhouses, chicken yards, and pig pens. The result is that the poisonous waste from these places seeps through the soil and into the drinking water. If the subsoil is gravel the impurities soak through it very rapidly. Those who drink the water are, of course, in danger of having typhoid fever.

Often wells are not properly constructed. The opening may be in a depression slightly

below the surface of the surrounding land. So, after a heavy rain, the surface water washes the

A well located near a barnyard from which poisonous wastes enter the drinking water

germ-filled earth from the upper layer of the soil into the well. This makes the water just as dangerous to use as if a strong poison had been poured into it. Sometimes the farmer gets his water supply from a spring which comes from the drainage of cesspools and barnyards located on higher ground. There is usually no board of health to warn him that he can depend upon the purity of spring water only when it rises from deep sources. There is no one to compel him and his neighbors to select elevated ground for their wells, at a safe distance from all cesspools, and to build their outhouses on the dry earth plan and without vaults. Small village communities, however, often have health officers to advise the people of the necessity of a pure water supply and to show them how to obtain it.

Do some diseases thrive best in the country? Besides typhoid, a few diseases, such as hookworm, seem to thrive best in the country. They are really a product of habits of living, especially in warm climates. In the Southern States of our own land, the worm which causes the hookworm disease develops in soil that has been poisoned by waste matter (feces) from human beings. It may enter the body in drinking water, but more often it enters through the skin of the feet. Children and adults who make a practice of going barefoot easily fall victims to it. The hookworm finds its way into the intestines, where it lives and multiplies, weakening the entire system. The child who is attacked by it does not grow as he should. His mind is weakened as well as his body, and in many cases he dies of the disease.

So great have been its ravages that national and state governments have come to the aid of local authorities in an effort to stamp it out. As in tuberculosis, the most good is done by telling the people the cause of the disease. They are shown that cleanliness is the chief requirement. Pollution of the soil should be avoided. All outhouses should be kept clean. Children should not be allowed to run barefoot on polluted ground. To-day there is every prospect that the hookworm will be entirely destroyed.

Thus we see that country life has its dangers as well as city life. We also see that cleanliness, pure air, and a good water supply, whether in the city or in the country, are the principal things necessary to good health.

QUESTIONS TO HELP THE PUPIL

1. Name some of the most common children's diseases. 2. Is it wise or unwise for children to visit their playmates who are ill? 3. What is a quarantine? 4. Name the shortest and the longest period of incubation mentioned. For which diseases? 5. How long must one be quarantined? 6. Show how decaying teeth injure health. 7. Name several ways in which the city and state governments help the people to keep well. 8. Is it a good or bad plan for many children to drink from the same cup? 9. Can you think why the city should need to have a building and housing department? 10. How is smoke an injury to health? 11. What can be done to prevent such injury? 12. What are vital statistics? 13. Are your vital statistics recorded? 14. What officer in your town should have them? 15. Whose duty is it to furnish him with those statistics? 16. What use does the government make of them? 17. Give another name for "consumption." 18. What causes it? 19. Name the best ways of preventing it. 20. Show how a person who is ill with tuberculosis can keep from infecting others. 21. Name one disease that thrives better in the country than in the city. 22. How may it be prevented?

XV. How to Handle Accidents and Emergencies

What is "first aid"? It often happens when children are playing that they hurt themselves, sometimes very badly. They may cut themselves or they may be so unfortunate as to fall and break an arm or leg. Sometimes bones are thrown out of place or the ligaments holding them together at the joints are strained. There are many other hurts from which children, and grown people as well, may suffer.

In all accidents the important thing is to help the unfortunate one as quickly as possible. This is called "first aid." In a great many instances first aid has saved life. In other cases it has spared the victim much pain or saved him from lasting injury.

Most first-aid measures are so simple that a child may easily learn them. It may be that by learning these measures you may know what to do in cases of emergency when older persons stand helpless.

How may we give first aid to the drowning? Many lives have been lost by drowning that could have been saved if those near by had known what to do. When a person is under water he naturally cannot breathe [illegible] is

not drawn out of the water within a few minutes his heart action stops. If he can be rescued and if treatment can be given within fifteen or twenty minutes, in many cases he can be revived. It is of the utmost importance that no time be lost. A few seconds of delay may mean death.

First place the patient, face downward, with head lower than the rest of his body. Roll him gently from side to side, or place the hands under the body at the waist line and with his head still hanging down partly lift him from the ground. This will allow the water to run out of the mouth and lungs. Next free the mouth, throat, and nostrils from anything that would hinder breathing. All of this must take but a few seconds of time.

Now turn the patient over on his back. The important thing is to get him to breathe and that as quickly as possible. To all appearances the person is dead. The heart has almost stopped beating; the breathing has entirely ceased. It is necessary then to try "artificial respiration." This is brought about by moving the muscles and bones of the thorax (page 24) as they move in natural breathing, thus allowing the air to pass in and out of the lungs. If begun quick enough, this treatment may stimulate the heart, lungs, and diaphragm to action again, and thus save the patient's life.

In order to bring about artificial respiration, first press the arms firmly against the sides of the body. Then, grasping them between the hands and elbows, lift the extended arms upward and outward until the hands touch above the patient's head. The arms will now, of course, be nearly parallel to the ground on which he is lying. Hold them a second in this position, then, reversing the action, bring back the arms to the first position against the patient's body. After another second's rest, repeat the movements. The entire movement, from sides to position above the head and back to sides, should be made about fifteen times per minute, for two hours, or until breathing begins. It is important that there should be no interruption during that time. Meanwhile care must be taken to keep the patient's tongue pulled forward, away from the windpipe, so that the air passage may not be blocked.

Artificial respiration is useful in cases of suffocation as well as all other cases in which the patient has been deprived of air so long as to stop the natural process of breathing.

What is a pulmotor? A machine has been invented which induces breathing by pumping oxygen into the lungs. This machine is called a *pulmotor*. It is much used by physicians in treatment of drowning, or in case of [illegible]ation

by gas, or in treatment of pneumonia or other diseases of the respiratory organs when the patient has difficulty in breathing. A pulmotor is not usually available as first aid. The location of pulmotors in the community should be generally known so that one may be sent for immediately while the first-aid work is going on. Efforts to revive a drowned person should be continued until the body grows cold and *rigor mortis* ("death stiffness") sets in.

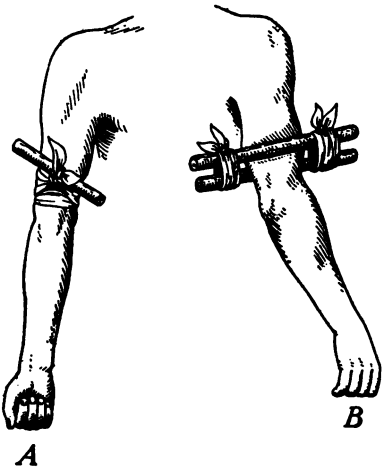
How should wounds be treated? The important thing in the first treatment of wounds and cuts is to get them clean. Such injuries are often received from objects that are soiled or rusty. Cuts bleed freely and the blood helps to wash out the impurities. But wounds made by nails or pointed objects sometimes do not bleed. Dirt and dangerous bacteria are driven into the flesh. In such cases if the wound is deep and cannot be cleaned out by using soap and water, it is best to see a physician to avoid danger of poisoning. All wounds, no matter how slight, should be washed in a weak solution of bichloride of mercury, a solution of iodine in iodide of potash, or of carbolic acid. Not more than three and a half ounces of carbolic acid should be used to a gallon of water.

How may bleeding be stopped? If wounds are small the blood has a way of stopping itself

from flowing. When the blood comes into contact with the air, it thickens to jelly-like masses called *clots*. These clots, if undisturbed, really do wonderful work, for they stop up the torn blood vessels, so that bleeding ceases. They also afford a substance through which, almost immediately, begin to grow the tiny fibrils of tissue that are to heal and mend the wound. Clots also perform another service. In closing and sealing the wound, they protect it from the entrance of poisonous germs.

In case of large wounds, the bleeding proceeds so rapidly that the clots do not have time to form. In such cases some other method must be found to stop the bleeding. Deep cuts which seem to have severed an artery or a vein should be treated by a physician. But until the physician arrives, the flowing of blood can usually be checked by pressing the thumbs firmly down on both sides of the wound upon the blood vessel that has been cut. Sometimes it is necessary to twist a knotted handkerchief tightly about the limb with the knot over the bleeding vessel, and pressing upon it, as in the picture on the opposite page. If the blood is of a bright red color and if it comes in jets, in time with the heart beat, an artery has been cut and the handkerchief must be tied between the wound and the heart in order to stop the flow

The arteries, as we have learned (page 84), carry the blood away from the heart. The veins carry it to the heart, so that when a vein is cut the blood flows out in a steady stream. In such cases the handkerchief should be tied on the side of the wound away from the heart, or better on both sides of the wound. But the tight pressure should not be kept up for too long a period. To avoid injury to the limb from lack of blood, the pressure may be released for a short time and then applied again until the physician arrives.



To stop bleeding from arteries
A, Spanish windlass; *B*, tourniquet

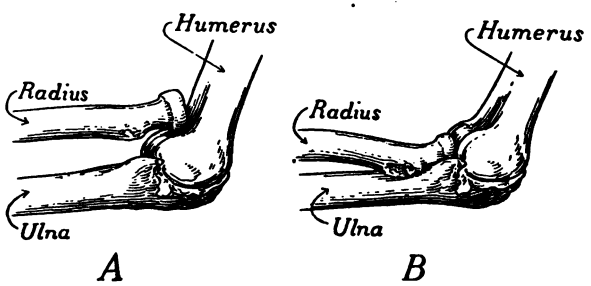
Place the patient who is losing much blood, with his head lower than his body, so the blood will flow into the brain, and thus insure against fainting. Raise his head very slowly when he is to be moved. In extreme cases the legs should be lifted and the arms bandaged from the tips of the fingers upward to force as much blood into the brain as possible. Keep

cool and do not be scared at the sight of blood. Don't forget these three essential things: (1) Send for the doctor. (2) Stop the bleeding. (3) Keep the patient's head lower than his body and keep him still.

How should wounds and cuts be bandaged? It is no easy matter to bandage an injured limb securely unless one knows just how to go about it. When the injured part is of even thickness, the bandage may be rolled firmly around, covering each time half of the preceding turn of the bandage. Care should be taken not to make the bandage too tight. If the injured part is of uneven thickness the bandage may be made to lie smoothly by folding it back upon itself so as to make it fit the injured member. After the bandaging has been completed, the end should be firmly sewed. Stitches may also be taken through each turn of the bandage to secure it from slipping. School children should be taught how to act in cases of drowning, how to apply pressure to arteries and veins, how to apply bandages, and other first-aid help.

When is there danger of lockjaw? The bacillus of tetanus (*lockjaw*) is often carried into deep wounds by nails and splinters. When the physician arrives he will inject bichloride or carbolic acid to the very bottom of the wound to kill the tetanus germ.

What is to be done in case of broken bones and dislocations? In case of broken bones or dislocations the first thing to do after placing the patient in a comfortable position is to call the doctor. Such injuries require expert care in order to avoid harmful effects that would last throughout life. When a bone is broken the doctor brings the broken ends of the bone together as carefully as possible. He then uses



The bones of the arm, showing dislocation and normal position
A, dislocation of the radius upward; *B*, radius set

bandages that will keep the broken ends from slipping. The bone will then grow together again and in time become as strong as ever.

Dislocations are caused when the end of a bone slips from the place in which it fits (the socket) into another place. In such injuries, which often result from a fall, the doctor must bring the end of the bone back into place. This usually causes much pain; but if it were not done, permanent deformity would result and the

patient would be unable to move the limb with as much freedom as if the joint had not been dislocated. Persons suffering from these injuries should be moved as little as possible until the surgeon arrives.

What is a sprain? In playing, children sometimes strain the ligaments that hold together the bones at the joints without breaking or tearing them. Such injuries are called sprains and are very painful. Applications of very hot water should be made, followed by washing in cold water. The sprained joint should then be bandaged tightly. Sometimes it takes a long time for a sprain to get well. It is best to give the joint a little very gentle exercise as soon as it can be borne, beginning on the day following the accident if possible. This may prevent a long-continued stiffness of the joint.

What should be done in case of freezing or frost-bite? In very cold weather it is not unusual for a person to have his ears or nose frozen. The first acute pain caused by cold is followed by a feeling of numbness which often results in causing the victim to think the danger is passed. But any one looking at the frozen member can see immediately what has happened. The best thing to do in such cases is to bury the frozen nose or ear in snow. The thing to be avoided is standing near the fire to get the

warm. Frostbites must be thawed out slowly or they are likely to give trouble by subsequent inflammation.

What is chilblain? After a frostbitten hand or foot is entirely well there is often a very disagreeable and to a certain extent intermittent itching, pricking, or burning sensation, especially in cold weather. It lasts often many months or even years. It is apt to be most troublesome in the evening, causing great discomfort. Bathing the parts in very cold water or in snow has a temporary soothing effect.

How may the victim of sunstroke be relieved? Cases of sunstroke are caused by too long exposure to the direct rays of the sun. The person becomes overheated and a feeling of dizziness results. The skin of the person suffering from sunstroke is hot and dry and the face is flushed. Cold water should be poured over the head and face and in extreme cases the body should be rubbed with ice. The patient should be placed in a sitting position, not reclining. Alcoholic drinks should not be given, as they have a depressing effect on the heart.

What is heat prostration? This trouble is quite different from sunstroke. The patient becomes very weak and depressed but usually does not lose consciousness. It is really a state of collapse. The face is moist with a cold sweat,

breathing shallow, and pulse faint and often very quick. The patient should be placed in a cool room or in the shade, flat on his back. His face and body should be bathed in water of about 70° to 80° F. A cool drink should be sipped, but no alcohol should be taken into the system. The feet and hands should be rubbed until the circulation is restored. Tea, coffee, or aromatic spirits of ammonia may be given.

How may a fainting person be revived? It is known that fainting is caused by a lack of blood in the brain. For this reason a person who has fainted should be placed at full length with the body so inclined as to be much higher than the head. The face should then be bathed in cold water and the clothes loosened to make breathing easy. All windows should be opened and the room kept free from all persons who are not needed as assistants. Some persons faint very easily. Others faint when they see blood. Most cases of fainting occur in overheated and overcrowded halls.

What can be done to relieve bites or stings? We have learned (page 145) the great danger of hydrophobia from the bite of an animal. Treatment should be given by a physician as quickly as possible to prevent infection. The patient should be taken to a Pasteur Institute, a branch of which is located in every large American city.

The Pasteur hydrophobia serum may also be obtained through the mail and injected by the local doctor.

The pain of bee stings may be helped by applying a cloth soaked in ammonia or peroxide of hydrogen. These substances are also useful in relieving mosquito bites (page 61). If the person who is stung by a bee or wasp happens to be near water, he can get a bit of cool mud to put on the sting. This will relieve him until he reaches home, where he may have more effective treatment.

How are snake bites treated? These are very rare in this country. Rattlesnakes, copperheads, and hissing vipers are nearly extinct. The bites of these snakes are very dangerous and should be treated by a doctor immediately. It is well to twist a handkerchief above the wound as in the case of deep wounds (page 195) to keep the poison from circulating in the blood. Sucking the wound will draw the poison out, but there should not be sores in the mouth or lips for then the danger to the first-aider would be very great. The wound should be made to bleed by cutting, for the flow of blood may help to wash out the poison from the snake's fangs. Application of a solution of permanganate of potash to the wound as soon as possible is advisable.

In order to bring about artificial respiration, first press the arms firmly against the sides of the body. Then, grasping them between the hands and elbows, lift the extended arms upward and outward until the hands touch above the patient's head. The arms will now, of course, be nearly parallel to the ground on which he is lying. Hold them a second in this position, then, reversing the action, bring back the arms to the first position against the patient's body. After another second's rest, repeat the movements. The entire movement, from sides to position above the head and back to sides, should be made about fifteen times per minute, for two hours, or until breathing begins. It is important that there should be no interruption during that time. Meanwhile care must be taken to keep the patient's tongue pulled forward, away from the windpipe, so that the air passage may not be blocked.

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But some acids and alkalies—for example, nitric and carbolic acids, caustic soda and ammonia—are so strong that they immediately begin to eat away the tissues of the stomach, and nothing can save the patient's life unless the remedy is applied instantly.

Fortunately, acids and alkalies neutralize each other. That is, if used in right proportions, each will destroy the peculiar qualities of the other. If, then, ammonia has been swallowed, seize the vinegar cruet from the dining-room table and instantly administer its contents to the patient. If carbolic acid has been swallowed, give baking soda dissolved in a quantity of water. Then with the doctor's aid the stomach should be washed out and soothing medicines given to heal the injured tissues of the mouth, throat, and stomach. White of egg beaten up and mixed with water is one good substance that can be used for this purpose.

How should ivy poisoning be treated? Persons living in the country or those who visit the country in vacation are sometimes poisoned by a certain kind of ivy growing wild in the woods or in underbrush along roads and streams. It may be found in any place where vegetation has a chance to grow. Everybody should know what poison ivy looks like. A study of the illustration will help you to recognize it so that

you may avoid the disagreeable and sometimes dangerous effects of the poison. If the leaves touch the skin anywhere, the place quickly becomes swollen and blistered. The best way to avoid ivy poisoning is to wash the hands and face thoroughly in soap and water. Moistening the exposed parts with a dilute solution of sugar of lead is helpful in removing the poison from the skin. Rubbing the affected parts with alcohol is also effective. Some persons are more susceptible to ivy poisoning than others; some are not affected at all. In severe cases of ivy poisoning a physician should be consulted.

Poison ivy

What is the Red Cross Society? This is an international organization having its headquarters in Switzerland. The headquarters for the United States is in Washington. There branch societies in all the states and in

large cities. The purpose of the Red Cross is to help peoples who suffer from fires, floods, storms, famine, earthquakes, shipwrecks, and wars. Its societies send nurses and food, doctors and drugs, bandages and splints, and all things necessary to save life and relieve suffering caused by disaster. They care especially for sick and starving children in the stricken areas. They teach all their employes first-aid principles. If you learn all the things which you have been told about in this chapter you can join the Red Cross band.

QUESTIONS TO HELP THE PUPIL

1. What is meant by the term "first aid"? 2. Name some of the accidents most common among school children. 3. How would you give first aid to a drowning person? 4. What is the purpose of these artificial arm movements? 5. How would you use a pulmotor? 6. Suppose a comrade cut an artery or vein. State exactly what you would do for him. 7. How can you tell whether to place the knotted bandage above or below the wound? 8. Which wound is the more dangerous, that of the artery or that of the vein? 9. What precautions would you observe in bandaging a wound? 10. What should be done for a deep wound made by a nail or similar object? 11. What should you *not* do in case of a broken bone or dislocation? 12. How would you treat a sprained ankle? 13. What should be done for frostbite or chilblains? For sunstroke or heat prostration? 14. How should a fainting person be revived? 15. How are bites or stings of insects relieved? Snakebites? 16. What can you do for a person who has swallowed poison? 17. What precaution will you take against ivy poisoning? 18. Tell all you can about the work of the Red Cross Society. Do you belong to it?

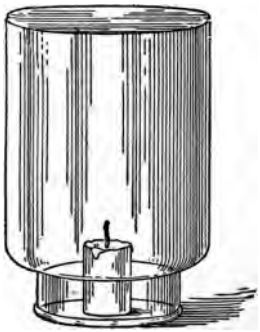
XVI. Health Habits

We have been reading in this book about such ordinary things in the world about us as air, dust, warmth and cold, mosquitoes and flies, fire and water, and such simple acts of living as breathing, sleeping, eating, drinking, and bathing. All are such everyday realities and experiences that we had accepted them as a matter of course. But now we know that these common experiences have very important relations to life, health, and happiness, and that it is very necessary for us to know what those relations are.

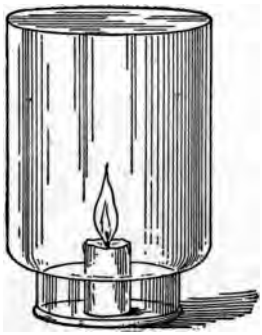
What have we learned about the air in relation to life and health? We have learned that air is made up of a number of gases. These gases are nitrogen, oxygen, carbon dioxide, water, argon, krypton, and xenon, and are known as the natural constituents of the air. We have learned that the body must have oxygen in order to live. This oxygen is taken into the lungs in the process of breathing. There it enters the blood vessels through the walls of the lung cells and is carried by the blood to every part of the body.

What have we learned about combustion? By experiment we know that in rare cases

(chlorine and hydrogen will burn) there can be no fire without oxygen. Combustion or burning is a chemical process. In this process oxygen unites with the hydrogen and carbon



This candle has gone out because there is no oxygen in the jar



This candle continues to burn because the oxygen is not yet used up

in the substance that is burning and produces gases, principally carbon dioxide, mixed with water. You have read that a process of burning goes on in the tissues of the body and that the oxygen it needs is brought by the blood from the air cells of the lungs. Most of the carbon dioxide and some of the water left by the burning is carried away by the blood and brought to the lung cells, where it is thrown out into the air in the process of breathing. The remainder of the waste material is sent out of the body by way of the skin, the liver, and the kidneys.

So we see the vital importance of breathing. Besides making it possible for the lungs to throw out the water and the poisonous carbon dioxide taken from the blood, it also gives them the opportunity, at the same time, to take from the air the stimulating, life-giving oxygen so necessary to our existence.

Plants breathe in carbon dioxide, retain the carbon, and send the oxygen back into the air

But why is not all the oxygen in the air used up, and the air filled full of carbon dioxide? Nature provides in a wonderful way that this shall not happen and that there shall always be enough oxygen in the air for all purposes of life. Nature has covered almost all the surface of the earth with plant life. These plants breathe in the carbon dioxide that animals breathe out. The plants then take the carbon out of the carbon dioxide, use it in build-

their leaves and stems, and send the oxygen back into the air. In this way the proper balance is kept in the supply of oxygen and carbon dioxide.

We have also learned that grave dangers lurk in the air we breathe. Impurities, dust, germs, and bacteria swarm there to our peril, in most cases caused by our own carelessness. We have read how nature provides us with safeguards against these dangers. In the blood, patrolling all the veins and arteries, are thousands of white-coated policemen. These policemen attack disease germs and drive them away or destroy them utterly. If we keep our bodies sound and strong by good health habits, we may help these vigorous phagocytes or "cell eaters" in their work of guarding us against disease.

The importance of health habits. In all we have read we have seen how much depends upon our own acts. By doing or not doing certain things, we can help or hinder the proper functions of the body, and so either safeguard or destroy health and happiness. We have read how we may develop the organs of breathing by exercise and play, and how necessary it is to establish habits of cleanliness, of correct breathing, drinking, eating, and sleeping. We will now study more carefully what a habit is. We learn how easy it is to acquire good

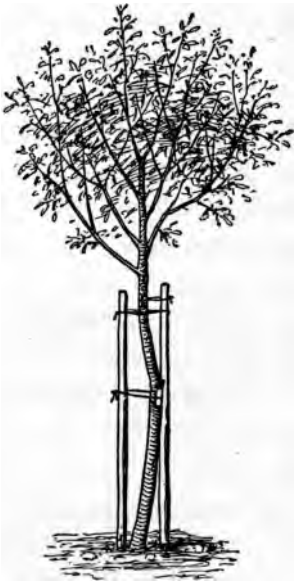
health habits, and of how much benefit they are to us in increasing our ability to resist sickness, in helping us to be bright and cheerful, and in making our success in life sure.

What is a habit? A habit is a tendency on our part to do a certain thing easily and without giving any special thought to the action. A habit is formed by doing a certain thing over and over again every day. Each time it becomes more easy to do, until finally we can do it without giving it any thought whatever. We feel unhappy if anything prevents us from doing the habitual things.

A crooked old tree. This is the result of not correcting a bad habit of growth when the tree was young

Are bad habits as easily formed as good habits? Yes, bad habits are formed just as easily as good habits. The way in which we do such everyday things as breathing, eating, thinking, standing, sitting, or walking is determined by habit. We have learned that these actions are of the highest importance to health. We may just as easily do them in

the right way as in a way that will injure our health. What we must particularly remember about habits, whether good or bad, is that when a habit is once fixed, it is very hard to break.



Correcting a bad habit of growth in a young tree

Is it important to form health habits while young? It is very important to start health habits while young. The earlier we begin the easier it will be for us to form good habits, and the stronger and more helpful they will become. You have perhaps seen an old tree that has grown very crooked. It is impossible now to make it straight without breaking it. But if that tree had been held up by stakes while it was young, it would have grown up straight and strong. It is just the same way with a person. If he grows up with a bad habit it will be very hard for him to change. He will grow crooked, he will not be pleasing to look at, and his health will be bad. But if he forms good habits while young he will grow up straight and strong.

What are good habits of breathing? Any one who wishes to have good health must form the habit of breathing deeply, and always through the nose. We have read (page 49) how outdoor play and certain exercises of the arms and shoulders will help develop the organs of breathing and increase the strength of the muscles of the thorax and the heart. The purpose of such outdoor play and exercise is to help us form the habit of deep breathing, in order always to provide our lungs with a plentiful supply of oxygen, so essential to every activity of the body.

Breathing through the nose protects the lungs, for the dust and impurities in the air are caught by the curves, the fine hairs, and the mucous membrane in the nasal cavities. Mouth breathing allows them to be sucked down into the throat, lungs, and digestive tracts. In this way many dangerous diseases are contracted. Then, too, in winter, air breathed through the mouth may chill the throat and lungs so much as to produce inflammation of those organs. Air that passes through the nostrils becomes somewhat warmed before it reaches the lungs. At all times mouth breathing dries the mucous membrane of the mouth and throat so that it cannot do its work so well.

The habit of properly fillir [illegible] full

of good, clean air is beneficial not only to the lungs but to all the internal organs. There is a close relationship between the action of the lungs and the action of the heart. By filling the lungs with good, clean air, circulation is increased, thus stimulating the functions of all the organs with which the blood comes in contact, the digestive organs, the excretory organs, the brain, the muscles. Every part receives renewed vigor.

The effect of tobacco smoke on the organs of breathing. In our discussion of the importance of air and the process of breathing to our life and health, it is necessary to call attention to a very foolish and dangerous habit which a great many persons have formed. We all understand that pure air is absolutely necessary for our health and well-being. In spite of this, thousands of persons deliberately poison the air they breathe with tobacco smoke, endangering not only their own health but that of all those who come near them.

Tobacco contains large quantities of a very poisonous substance known as nicotine. This poison may be carried into the mouth and enter the circulation through the stomach or through the lung cells, and be carried by the blood to every part of the body. It also causes the mucous membrane covering the inside walls of the

mouth, nose, and throat to become inflamed.

When the tobacco habit is once established it is one of the most difficult to break. There are instances in history of great men who have fallen victims to the tobacco habit. General Grant died in the prime of life of throat cancer said to have been caused by the constant smoking of cigars. Frederick the Great used tobacco to excess, particularly snuff, and it is said his death was hastened by it.

Cigarettes are especially dangerous. They weaken the power of the lungs to resist disease, and they favor the spread of many dangerous diseases.

Good habits in ventilation. It is of vital importance to form good habits in ventilation. We know (page 73) that unless the air is continually changed in the rooms in which we live, we become oppressed and feel badly. If we continue to live in unventilated rooms our health will surely break. Unventilated rooms also favor the spread of colds, catarrhs, and all kinds of germ diseases.

We have read (pages 75–77) of mechanical ventilating appliances installed in large buildings, schools, halls, and assembly rooms, and in the dwellings of wealthy persons. But in most dwelling houses we must depend on windows and doors for ventilation. [illegible] important

health habit always to be sure that a window is open a few inches from the top and another window a few inches from the bottom. The warm impure air will flow out at the top and the good fresh air will enter at the bottom. So we may make the air circulate in our rooms, and always have good pure air to breathe. It is well to have the windows on opposite sides of the room.

In our sleeping rooms we should be still more sure of a plentiful supply of fresh air. There we should open the windows wide both winter and summer, taking care in winter to keep our bodies warm with sufficient clothing. A sleeping room should never be artificially heated except in cases of extreme cold. In other words, the temperature in the sleeping room should be the same as that outdoors, in both summer and winter. In the living rooms the temperature should not be over sixty-eight degrees in winter.

Health habits of cleanliness. One of the most important and best health habits we can form is that of cleanliness. A clean, healthy skin is the chief essential of attractiveness. Faces and especially hands, which come in contact so often with the dust and dirt in the air and on objects, need washing several times a day.

We should always wash our hands before

A public washroom. The soiled towel is a menace to public health

eating, being careful to use pure soap and thoroughly to rinse it off before drying. Clean hands are less liable than dirty hands to carry disease to the mouth or to impart disease to others.

Never dry your hands on towels used by persons in public places. Always have your own towel, and so avoid skin and other diseases which those persons may have had who used the towel before you.

What will happen if the pores of the skin become clogged? We have learned (pages 107, 108

how waste materials are thrown off through the sweat glands of the skin. If we fail to cleanse the skin thoroughly and very often, these impurities may be reabsorbed. Finally the pores will clog and will be unable to perform their functions. Poisonous waste will be retained in the body and health will be endangered.

Still another trouble may come through this clogging of the pores. The heat of the body is largely regulated by the combined activities of the lungs, the capillaries, and the skin. You know how much cooler your hand feels when it is moist. It is because the moisture in evaporating takes away from the hand some of its warmth, thus giving the sensation of coolness. Just so the moisture that is expelled in breathing (which you can see if you breathe upon a mirror or a cold window pane) carries away some of the heat of the lungs.

The skin helps to control the temperature of the body in very much the same way that the lungs do, sending out through the sweat pores more or less moisture from the blood, which, as it passes into the air, takes away some of the body heat.

It is plain that if the pores are clogged, the skin will not be able to do this work of cooling in the As a result the body to be feverish.

Because the skin is not doing all its work, the lungs may be oversupplied with blood, thus favoring lung fever, as such a condition is sometimes called. One of the first things the doctor does in case of fever is to give medicine or other treatment to bring about sweating. This simply means that in some way or other he starts the pores to work again and makes them continue to throw off moisture and poisonous substances from the blood.

The daily morning bath. A daily morning bath of the whole body is an important health habit. The ideal temperature for the morning bath is sixty-eight degrees. For children under three years of age the temperature should be from eighty to ninety degrees. The rubbing one receives in bathing and the cleansing properties of the water promote the healthy action of the skin, the blood circulates more freely, and the skin looks fresh and clean.

While the daily morning bath removes the wastes and impurities that have been thrown off through the pores of the skin, we must not forget that the bed clothes in which we have slept retain some of these impurities. For this reason a very valuable health habit is to air the bed clothing thoroughly every day. Thus you will sleep soundly and well and avoid the danger of reabsorbing the old wastes and impurities.

It is certain that there can be no bad habits of cleanliness. Cleanliness cannot be carried to any too great extreme. The cleaner we keep our bodies the better we feel, the more attractive we are, and the better we can play, study, or work. We cannot be too clean. Being clean, however, should not be such a fad as to make one miserable.

A bath thermometer

Health habits in drinking. We must not forget in discussing the value of water to health in its cleansing properties, that it has another great value, that is, its use as a beverage. Pure water is the most healthful beverage we can use. It is the beverage that has been supplied to us by nature to satisfy our thirst. But we must be careful of its purity, its temperature, the amount we drink, and when we drink it. We should not drink more water than thirst requires, its temperature should not be lower than fifty-five degrees, and we should not drink much while chewing food. Ice-cold beverages are very dangerous, especially during the hot summer days (page 117).

We have also been warned (pages 116–117) against the great danger of alcoholic drinks, many so-called soft drinks, and tea and coffee

because of the poisons they contain. The use of such drinks causes us to form bad habits, habits that are very hard to break, and make us grow wrong like the crooked tree. Let us form the habit of drinking pure water only, at a temperature not lower than fifty-five degrees, and but little while chewing food.

Cleanliness in our surroundings. Though we may establish health habits of personal cleanliness, the good effects of such habits will be much reduced if our surroundings are not clean.

On a windy day the air is filled with germ-laden dust from untidy streets and gutters

Our rooms, our playground, the back yard of our house, the street in front of the house all these must be clean, if we wish to guard our health.

We have learned how germs are carried in the dust in the air, and that we must use damp cloths and vacuum machines in cl ing our room order to prevent dust from flying. We ha how darkness favors the gr mo

bacteria, and how light will destroy them. So let us see that our rooms are bright with sunlight, full of good air, and thoroughly clean.

The refuse and rubbish of an uncared for yard help to spread disease

We have been told that the windows of our sleeping rooms should be kept wide open, and better still, that we should sleep outdoors in what is called a sleeping porch. But what good will that do if the neighborhood is littered with refuse of all kinds, filling all the air with the spores and bacteria we are seeking to avoid? So let it be our duty to see that no refuse is allowed to remain in our homes, nor anywhere near our homes. It must be destroyed or removed as soon as possible.

Good habits in playing. Though it is fine fun to play outdoors with the boys and girls, and good for the health, we must be very not to overdo it. We may grow so fond at we are late for school, or do not go school as our mothers tell us to do,

or do not get our lessons. That is a very bad habit. We must remember that there is a time for work and a time for play.

It is also bad for our health to carry our play to excess; that is, to play too hard, as we say. Violent play, running long and fast, sports requiring great exertion, should be avoided. Such games overtax the muscles and are very dangerous for the heart and other vital organs.

Going directly home from school is a very good habit

When you find that you are breathing very hard and your heart is beating very fast, it is best to stop playing and remain quiet until you are rested and your breathing is easy and natural. Above all, never try to d[illegible]thing that is dangerous or beyond h to do, such as lifting very hea

jumping down from any great height to a hard surface. That kind of play is likely to ruin your health entirely. It is particularly dangerous to the spine.

The ideal boy or girl that we should keep in mind. We have seen boys and girls toward whom we have felt very much attracted. They are always cheerful, clean, healthy, and bright. They always know their lessons, they are obedient, they are kind to everybody they meet. You may be sure that these boys and girls have formed all the health habits about which we have read in this book. We feel a desire to be like them. All that is necessary is for us to begin the health habits of which we have read. At first we shall have to set ourselves to do certain tasks, or to do things in a new way. But after a short time, if we neither give up, nor slacken our efforts, these new ways will become part of ourselves; it will not require the slightest effort to follow them, and soon we shall be bright, cheerful, kind, clean, and healthy, like those attractive boys and girls whom we admire.

QUESTIONS TO HELP THE PUPIL

1. What gas must the body have in order to live? 2. Name some of the natural constituents of the air besides oxygen. 3. What gas is formed in the process of combustion? 4. What becomes of the carbon dioxide rmed in the body? 5. How has nature provided that re shall always be enough oxygen in the air for men

and animals to breathe? 6. What dangers lurk in the air? 7. How are we guarded against these dangers?

8. How is a habit formed? 9. Why should we form the habit of deep breathing? 10. Why should we breathe through the nose? 11. Why is air that is filled with tobacco smoke injurious? 12. What great men were victims of the tobacco habit?

13. How should the windows be opened so as to cause a circulation of air in the room? 14. What should we remember in regard to ventilation in our sleeping rooms? 15. What is the proper temperature for a living room?

16. What happens to the pores if we do not cleanse the skin thoroughly and often? 17. Why should we not use a public towel? 18. What habits should we form with regard to bathing? why? 19. What should be the temperature of the morning bath? 20. Why should we not use ice-cold beverages? 21. What kind of drinks should we avoid? why? 22. Why is it just as important to keep our surroundings clean as it is to keep our bodies clean? 23. How may we prevent much dust from flying in the air in our rooms? 24. Why should our rooms be bright with light and sunshine? 25. What effect does a yard littered with refuse have on the air of the neighborhood? 26. How does play affect our health? 27. What should you do when you have been running and feel your heart beating fast? 28. How may we become like the healthy, cheerful boys and girls that we admire?

THE VOCABULARY

[The diacritical marks used to indicate pronunciation agree with the latest edition of Webster's New International Dictionary.]

adenoid (ăd'ē noid)
amoeba (ȧ mē'bȧ); pl.-bae (-bē)
animalcule (an'i măl'kūl)
Anopheles (ȧ nŏf'ē lēz)
antiseptic (an'tĭ sĕp'tĭk)
antitoxin (ăn'tĭ tŏk'sĭn)
aorta (ā ôr'tȧ)
appendicitis (a pĕn'dĭ sĭ'tĭs)
inflammation of the appendix
argon (ār'gŏn)
arsenic (ār'sē nĭk)
a very poisonous mineral substance
attar (ăt'ȧr)
a fragrant oil made from rose petals
auricle (ô'rĭ k'l)
auto-intoxication (ô'tō-ĭn tŏk'sĭ-kā'shŭn)
poisoning from substances produced within the body

bacillus (bȧ sĭl'ŭs)
bacteria (băk tē'rĭ ȧ)
beta-naphthol (bā'tȧ năf'thŏl)
a substance found in coal tar
bichloride (bī klō'rīd)
a compound containing two atoms of chlorine in combination with other elements
bronchial (brŏŋ'kĭ ȧl)
bronchitis (brŏŋ kī'tĭs)
a germ disease affecting the bronchial tubes

caffeine (kăf'ē ĭn)
the element in coffee which stimulates
capillaries (kăp'ĭ lȧ rĭz)
carbolic (kär bŏl'ĭk)
carbon dioxide (kär'bŏn dī ŏk'-sīd)
carbuncle (kär'bŭŋ k'l)
cartilage (kär'tĭ lȧj)
catarrh (kȧ tär')
a disease affecting mucous membrane, usually of the nose and throat
chilblain (chĭl'blān)
chlorinated (klō'rĭ nāt ĕd)
treated, or caused to combine, with chlorine, a bleaching, disinfecting gas
cholera (kŏl'ĕr ȧ)
a bilious disease usually caused by carelessness in diet
clinical (klĭn'ĭ kȧl)
pertaining to the sick bed or hospital
cocaine (kō'kȧ ĭn)
a white bitter element obtained from coca leaves
coccus (kŏk'ŭs)
cochlea (kŏk'lē ȧ)
a part of the inner ear; so called because it is shaped like a snail shell
concha (kŏŋ'kȧ)
the largest and deepest hollow of the outer ear
contagious (kŏn tā'jŭs)
spreading by contact
corpuscle (kôr'pŭs'l)
costal (kŏs'tăl)
pertaining to the ribs
creolin (krē'ō lĭn)
the trade name for a preparation made from coal tar
cricoid (krĭ'koid)
a cartilage of the larynx; so called because it is shaped like a signet ring
culex (kū'lĕks)
cuticle (kū'tĭ k'l)
cutis vera (kū'tĭs vē'rȧ)

diaphragm (dī′ȧ frăm)
diarrhea (dĭ′ȧ rē′ȧ)
a disease affecting the bowels
diphtheria (dĭf thē′rĭ ȧ)
a germ disease of the throat
disinfectant (dĭs′ĭn fĕk′tȧnt)
anything, not to be used upon the living body, which may be used to destroy bacteria or germs
dysentery (dĭs′ĕn tĕr ĭ)
a disease affecting the large intestine

eau de Cologne (ō′dē kō lōn′)
eczema (ĕk′zē mȧ)
entomology (ĕn′tō mŏl′ō jĭ)
the science dealing with the study of insects
epidemic (ĕp′ĭ dĕm′ĭk)
any disease which spreads widely and affects great numbers
epidermis (ĕp″ĭ dûr′mĭs)
epiglottis (ĕp′ĭ glŏt′ĭs)
esophagus (ē sŏf′ȧ gŭs)
eucalyptus (ū′kȧ lĭp′tŭs)
a tree the leaves of which yield a fragrant oil
Eustachian (ū stā′kĭ ăn)
excretory (ĕks′krē tō rĭ)

ferment (fûr′mĕnt)
a substance causing action within, as does yeast
forceps (fôr′sĕps)
a pair of pincers
formaldehyde (fôr măl′dē hīd)
a gas with a sharp, penetrating odor
fumigation (fū′mĭ gā′shŭn)

genito-urinary (jĕn′ĭ tō-ū′rĭ nȧ rĭ)
connected with the organs which separate and remove the waste fluid of the body
germ (jûrm)

hepatic (hē păt′ĭk)
of or pertaining to the liver

humerus (hū′mĕr ŭs)
the bone of the upper part of the arm from shoulder to elbow
hydrogen peroxide (hī′drō jĕn pĕr ŏk′sīd)
a compound which bleaches or cleanses
hydrophobia (hī′drō fō′bĭ ȧ)
hyoid (hī′oid)
a U-shaped bone and also a membrane at the base of the tongue
hypertrophy (hī pûr′trō fĭ)

immune (ĭ mūn′)
incubation (ĭn′kū bā′shŭn)
infectious (ĭn fek′shŭs)
caused or spread by bacteria or germs
influenza (ĭn′flōō ĕn′zȧ)
a disease caused by bacteria affecting the nose, throat, and bronchial tubes and usually epidemic
infusoria (ĭn′fū sō′rĭ ȧ)
a microbe of animal nature found usually in still or stagnant water
intestinal (ĭn tĕs′tĭ nȧl)
having to do with the intestines or lower digestive canal
iodine (ī′ō dĭn; ī′ō dīn)

krypton (krĭp′tŏn)

lactic (lăk′tĭk)
of or pertaining to milk
larynx (lăr′ĭŋks)
legume (lĕg′ūm)

maggot (măg′ŏt)
a worm or grub
magnesia (măg nē′zhĭ ȧ; shĭ ȧ)
a light, earthy white mineral substance used in medicine
malaria (mȧ lā′rĭ ȧ)
meatus (mē ā′tŭs)
the passage connecting outer and inner ear

meningitis (mĕn'ĭn jī'tĭs)
meningococcus (mē nĭŋ'gō kŏk'ŭs)
menthol (mĕn'thōl)
a white, clear substance with odor and cooling taste of peppermint
mercuric chloride (mĕr kū'rĭk klō'rīd)
same as corrosive sublimate, a deadly poison
microbe (mī'krōb)
micrococcus (mī'krō kŏk'ŭs)
microörganism (mī'krō ôr'găn-iz'm)
mosquito (mŏs kē'tō)
mucous (mū'kŭs)
secreting, producing, or containing mucus
mucus (mū'kŭs)
a slippery fluid which moistens and protects the tissues which produce it

nicotine (nĭk'ō tĭn)
nitrate (nī'trāt)
a substance formed by the action of nitric acid on another substance
nitric (nī'trĭk)
related to nitrogen
nitrogen (nī'trō jĕn)
nitrogenous (nī trŏj'ē nŭs)
containing nitrogen
nodule (nŏd'ūl)
nucleus (nū'klē ŭs)
a central mass about which matter is gathered

oxygen (ŏk'sĭ jĕn)

palate (păl'ăt)
papilla (pȧ pĭl'ȧ)
a small projection
parasite (păr'ȧ sīt)
a plant or animal living in, on, or within some other living being
Pasteur (pȧs'tûr')
a French scientist
Pasteurization (pȧs'tĕr ĭ zā'-shŭn)
pathogenic (păth'ō jĕn ĭk)
permanganate (pĕr măŋ'gȧ nāt)
a salt obtained from an acid of manganese, a hard, brittle metal
permanganate (pĕr măŋ'gȧ nāt) **of potash** (pŏt'ăsh')
a chemical salt obtained by combining manganese and potash
peroxide (pĕr ŏk'sīd)
same as hydrogen peroxide
phagocyte (făg'ō sīt)
pharynx (făr'ĭŋks)
phenol (fē'nōl; fē'nŏl)
carbolic acid, a substance produced from coal tar
phosphorus (fŏs'fŏr ŭs)
pinna (pĭn'ȧ)
the outside ear
platinum (plăt'ĭ nŭm)
a heavy, almost silver-white metallic element easily molded but resisting chemical action
pleura (plōō'rȧ)
pneumococcus (nū'mō kŏk'ŭs)
pneumonia (nū mō'nĭ ȧ)
a germ disease affecting the lungs
potassium iodide (pō tăs'ĭ ŭm ī'ō dīd)
a colorless or white compound obtained by dissolving iodine in potash
protein (prō'tē ĭn)
the nitrogen in all vegetable and animal substances
protoplasm (prō'tō plăz'm)
protozoa (prō'tō zō'ȧ)
pulmonary (pŭl'mō nȧ rĭ)
having to do with the lungs
pulmotor (pŭl'mō tĕr)
pulse (pŭls)
pupa (pū'pȧ)
a form of insect growth, also called cocoon
putridity (pū trĭd'ĭ tĭ)
pyorrhea (pī'ō rē'ȧ)

quarantine (kwŏr'ăn tēn)

rabies (rā'bĭ ēz)
radius (rā'dĭ ŭs)
one of the two bones of the fore arm from elbow to wrist
rheumatism (rōō'mȧ tĭz'm)
a painful disease caused by germs, usually affecting joints and muscles
rhizopod (rī'zō pŏd)
a microbe of animal nature living mostly in water
rigor mortis (rĭg'ĕr môr'tĭs)

saliva (sȧ lī'vȧ)
the fluid which moistens the mouth
scabiecide (skā'bĭ ē sīd)
anything which destroys the mite causing itch
scabies (skā'bĭ ēz)
sensory (sĕn'sō rĭ)
having to do with sensation or feeling
sequelae (sē kwē'lē)
serum (sē'rŭm)
solvent (sŏl'vĕnt)
a substance, usually a liquid, which will dissolve or break up other substances and cause them to disappear
spirillum (spī rĭl'ŭm)
spore (spōr)
sporozoa (spō'rō zō'ȧ)
a microbe of animal nature living mostly in water
sputum (spū'tŭm)
staphylococcus (stăf'ĭ lō kŏk'ŭs)
Stegomyia (stĕg'ō mī'yȧ)
sternum (stûr'nŭm)
stomata (stō'mȧ tȧ)
small mouth-like openings
styrox (stī'rŏks)
a balsam or gum from certain trees
sulphate (sŭl'fāt)
a substance, or salt, formed by the action of sulphuric acid (obtained from sulphur)
systemic (sĭs tĕm'ĭk)
pertaining to the body or the system as a whole

tetanus (tĕt'ȧ nŭs)
thorax (thō'raks)
thyroid (thī'roid)
the large V-shaped cartilage of the larynx known as Adam's apple
tissue (tĭsh'ū)
substance; the materials from which the body is built up
tonsilitis (tŏn'sĭ lī'tĭs)
a germ disease of the tonsils
tonsils (tŏn'sĭlz)
tourniquet (tōōr'nĭ kĕt)
a bandage twisted tight with a stick to stop bleeding
toxin (tŏk'sĭn)
trachea (trā'kē ȧ; trȧ kē'ȧ)
tubercle bacillus (tū'bĕr k'l bȧ sĭl'ŭs)
tuberculosis (tū bûr'kū lō'sĭs)
tuberculous (tū bûr'kū lŭs)
typhoid (tī'foid)
a fever caused by bacteria which usually enter the body by way of the drinking water or food

ulna (ŭl'nȧ)
one of the two bones of the fore arm from elbow to wrist
uvula (ū'vū lȧ)

vaccination (văk'sĭ nā'shŭn)
vaccine (văk'sĭn)
veins (vānz)
vena cava (vē'nȧ cā'vȧ)
a large vein by which the blood is returned to the right auricle
ventricle (vĕn'trĭ k'l)

xenon (zĕn'ŏn)

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